

NATIONAL GEOGRAPHIC

A tiger with orange and black stripes is walking towards the camera on a large, moss-covered log in a dense forest. The tiger's face is in focus, and its eyes are looking directly at the viewer. The background is a lush green forest with many trees and leaves. The title 'NATIONAL GEOGRAPHIC' is printed in large white letters across the top of the image.

The Tigers Who Changed Their Stripes

Can the genetic
conundrum facing India's
big cats be solved?

P. 16

The Power of Aging Athletically

What science
is discovering
about exercise and
longevity

P. 40

Is Everest Really the Tallest Mountain?

A new way of
measuring could
reorder the world's
mightiest peaks

P. 86

A Fresh Way of Seeing Earth From Space

An astronaut and a
photographer invent
a new perspective

P. 112

Purina trademarks are owned by Societe des Produits Nestle S.A.

SO
GOOD,
THEY'LL



FLIP
THEIR
LID.



Steam-cooked real meat with veggies
in a convenient, resealable tub.

FROM *the* EDITOR

NATHAN LUMP

THE FIRST TIME I saw a tiger in the wild was in 2006. It was in India's Bandhavgarh National Park, and I was staying at a new lodge opened by an African safari company. Ahead of my visit, lodge management had tried to set realistic expectations. Tigers are elusive animals, and there was no promise I'd see one during my time there. But on my second day in the park, one strode out behind our vehicle onto the path, pausing its stride to take the measure of us in a penetrating gaze before heading back into the forest.

That sighting (the first of several) felt particularly momentous because tigers were in a perilous position at the time. Their numbers had been steadily declining for decades, hastened by poaching and habitat destruction as India's cities and agricultural lands expanded. The country has been protecting tigers in reserves since the 1970s, and the year before my visit it established the

National Tiger Conservation Authority to put more rigor around the effort. Two decades on, the work has paid off. Today the tiger population in India is estimated to have more than doubled.

The subject of this month's cover feature, from photographer, writer, and National Geographic Explorer Prasenjeet Yadav, is a surprising corollary to that success story: the tale of a great male tiger with a rare genetic mutation, which has highlighted what happens when an animal population rebounds but remains sequestered in a reserve, without access to a diverse gene pool. It reminds us that saving animals is just step one. We must then figure out how to ensure they thrive, which is exactly what a team in India has now set out to do.

I hope you enjoy the issue.

CONTENTS

6 **IN FOCUS** / 15 **CONTRIBUTORS**

16

THE CURIOUS CASE OF THE TIGERS THAT CHANGED THEIR STRIPES

India's rebounding tiger population is a cause for hope. But a genetic abnormality is prompting a high-stakes effort to bring isolated tigers together.

36

SHOULD WE RESCUE SPACE RELICS?

A scheme to retrieve the oldest orbiting satellite raises questions about what's history and what's just space junk.

40

OLDER, BETTER, FASTER, STRONGER

Today's older athletes are thriving longer than ever—and teaching us which habits matter. Plus, NFL star Jerry Rice, Olympic icon Nadia Comăneci, and others on how to age like a legend.

80

HOW JACKIE KENNEDY SAVED AN EGYPTIAN TREASURE

The unlikely story of the first lady's role in rescuing the ancient temples of Abu Simbel.

86

THE WORLD'S TALLEST MOUNTAIN? IT MIGHT NOT BE WHAT YOU THINK

A new way of looking at mountain majesty has revived old debates about summit supremacy. Have we been measuring the great peaks all wrong?

100

ICE HOCKEY IS FLOURISHING IN ... NAIROBI

The Kenya Ice Lions are equatorial Africa's only ice hockey team—and, in a stratified city, an egalitarian bastion.

108

WHAT WE GET WRONG ABOUT HISTORY'S MOST MALIGNED MAP

Gerardus Mercator took an unusual view of the world. But there's good reason it's so widely shared.

112

OUR PLANET FROM ABOVE & BELOW

National Geographic photographer Babak Tafreshi and NASA astronaut Don Pettit teamed up to photograph some of Earth's most breathtaking places. Pettit's vantage point: the International Space Station.

134 **NEW FROM NATIONAL GEOGRAPHIC**

ON THE COVER A tiger with an unusual coat prowls India's Similipal Tiger Reserve. About half of Similipal's roughly 30 tigers carry a mutation that widens their black stripes.

Photograph by PRASENJEET YADAV

IONIQ 9

Where closeness grows with space.



The IONIQ 9 opens up utmost comfort with space designed for shared adventures. Its serene, lounge-like cabin brings everyone together not just for the ride but for the memories made along the way.

Discover more on hyundai.com/worldwide



Non-U.S. model with optional features shown. Actual U.S. production model may vary.

IN FOCUS

JUST IN FROM OUR PHOTOGRAPHERS



NATURE

“It felt like a scene you might see in a documentary about the Serengeti but on a *small scale* and photographed in a FLOWER FIELD along a busy road in *densely populated* Holland.”

THEO BOSBOOM, *photographer*

Outside the Dutch village of Speuld, tension mounts as a stealthy crab spider stalks an unsuspecting fly on an oxeye daisy.

SKECHERS HANDS FREE **Slip-ins**

WIDE FIT | GLIDE-STEP

JUST STEP IN™

**NO BENDING OVER.
NO TOUCHING SHOES.
JUST STEP IN & GO.**



Introducing new Skechers Hands Free Slip-ins®. Putting on your shoes has never been easier. No bending over. No pulling them on. Just step in and go.



NEVER HAVE
TO TOUCH YOUR
SHOES AGAIN™

**MACHINE
WASHABLE**

Exclusive **Heel Pillow** holds your foot securely in place!

[SKECHERS.COM](https://www.skechers.com)



HOWIE
LONG



LEARN MORE

DISCOVER THE *WILD BEAUTY* OF **MAINE**

For National Geographic photographer Pete Muller, Maine offers more than scenic beauty—it represents clarity, connection, and resilience. On a journey through two of the state's most rugged regions—DownEast and the Blue Hill Peninsula—Muller explored the intimate relationships between people and places along the coast.

Photographs by PETE MULLER

» The trip began at the easternmost edge of the continental United States: **Lubec**, where the country's first light of day illuminates the **West Quoddy Head Light**.

Shrouded in fog, the early morning was accompanied by a dreamlike stillness—an apt prelude to kayaking the pristine waters of **Cobscook Shores**. Not long after, on a whale-watching tour in **Eastport**, Muller encountered eagles overhead, porpoises beneath his boat, and whales surfacing offshore, all within moments of leaving the dock.

After immersing himself in the water, Muller turned his attention to Maine's cultural and culinary traditions. He ventured into **Raye's Mustard**, the country's last traditional stone-ground mustard mill, and explored the

Tides Institute and Museum of Art, which celebrates the region's creative legacy. Eastport's small-town blend of working heritage and contemporary culture reflected a broader theme of resilience that echoed throughout Muller's journey.

Farther south, on the **Blue Hill Peninsula**, Muller found craftsmanship, tradition, and deep respect for the environment. In Brooklin, the enduring tradition of wooden boat building thrives at the WoodenBoat School, where students carry forward a centuries-old maritime craft.

Muller also visited **Deer Isle Oyster Company**, where sustainability takes center stage. Local oyster farmer, Abby Barrows, is reimaging aquaculture by using plastic-free mariculture gear in the water.

» Later at **Yellow Birch Farm**, that ethos is carried to the table, with a locally sourced, farm-to-fork feast set in a historic barn surrounded by fields, studios, and pastures.

Throughout the journey, Maine revealed itself as a place where nature shapes daily life and where human creativity and stewardship rise to meet it. From misty shorelines and forested trails to the shared warmth of community tables, the experience offered a timeless reminder of the power of place to shape who we are.

“I can honestly say that I wouldn't be the person that I am today if it wasn't for experiences that I have had in the state of Maine.”

PETE MULLER

National Geographic photographer



Explore [VisitMaine.com](https://www.visitmaine.com) to start planning your next trip.

MAINE.
FORGED BY NATURE

This is paid content. This content does not necessarily reflect the views of National Geographic or its editorial staff.



CULTURE

“They grew up in *this river*. Watching them explore WHO THEY ARE and who they will become through *movement* was a beautiful thing.”

SILVANA TREVALE, *photographer*

Wading in the Río Curiepe, on Venezuela’s Caribbean coast, dancers (from left) José Angel Chira Matos, Yormarlin Fernández, and Mairim Francisca Longa perform in the Afro-Venezuelan *culo ‘e puya* tradition, named for the drums that typically accompany the steps.

1M

What are pangolins? If you've never heard of the pangolin, you're not alone. Despite being little known, pangolins are the world's most trafficked mammal, with more than **one million** pangolins poached in the past decade.



PHOTOARK
JOEL SARTORE

When you leave a gift to the **National Geographic Society** in your will, trust or by beneficiary designation, you can protect critical animal species for generations to come. We believe everyone deserves access to estate planning tools. That's why we are offering a free resource to our supporters. Get started today! natgeo.org/givingdocs

THEIR FUTURE CAN BE **YOUR LEGACY**

- ☐ Yes! Please send me information on leaving a gift to the National Geographic Society.
- ☐ The National Geographic Society has already been included in my estate plans.
- ☐ I would like to speak to someone about making a gift. Please contact me.

Mail to: National Geographic Society
Planned Giving Office
1145 17th Street NW
Washington, DC 20036-4688

Contact: legacy@ngs.org
(800) 373-1717
natgeo.org/legacy

NAME

ADDRESS

PHONE

EMAIL

The National Geographic Society is a 501(c)(3) non-profit organization.
Our federal tax ID number is 53-0193519.



PA259MGG
PXXXXXXD



WILDLIFE

“All around them, there were pups nursing restlessly, wriggling, stretching their limbs and being CURIOUS AND PLAYFUL. This pup seemed *safe and calm* under its mother’s wings.”

KATE NEWMAN, *photographer*

At the largest colony of gray-headed flying foxes, sometimes called fruit bats, in Melbourne, Australia, a mother-and-pup pair enjoy a moment of rest.

**CUISINE
LIKE YOU'VE
NEVER,
EVER SEEN**

Fancy Feast Gems

A chef-inspired pyramid mousse pâté,
crowned with gravy. One look, and it's love.



PURINA
*Fancy
Feast*

LOVE IS IN THE DETAILS®



HEALTH

“He told me that he would like to be a *doctor* or maybe an *engineer*, but for now he only HOPES to finish high school.”

MARCO GARRO, *photographer and National Geographic Explorer*

Josué Tolentino lives in Cerro de Pasco, a mining town in the Peruvian Andes. His blood shows high levels of lead and arsenic, legacies of pollution. Garro developed this portrait using water contaminated with mining waste, a visual acknowledgment of the industry's corrosive effects on human health.

The shower that fits your lifestyle

Refreshing. Convenience. Elegance. Comfort.



Signature Showers
by **safestep**



FREE TOILET + \$1,000 OFF*
FOR A LIMITED TIME

1-800-989-6544

www.SignatureShowers.com

Signature Showers are manufactured and built in Tennessee. And we back our quality product with the best warranty in the business including a lifetime warranty on the shower.
*Offer expires 10/31/25. Free toilet with purchase and installation of a walk-in tub or walk-in shower only. Offer available while supplies last. No cash value. Must present offer at time of purchase.
Cannot be combined with any other offer. Market restrictions may apply. Offer available in select markets only.
CSLB 1082165 • NSCB 0083445 • 13VH11096000 • CGC1537181 • ROC 312990 • CCB 244331 • SAFESSW784PS • PA127501 • MHIC 134223 • TN 5887 • RL.884533 • RBB.49248 • UT 13229623-5501



OCTOBER

OCEANS

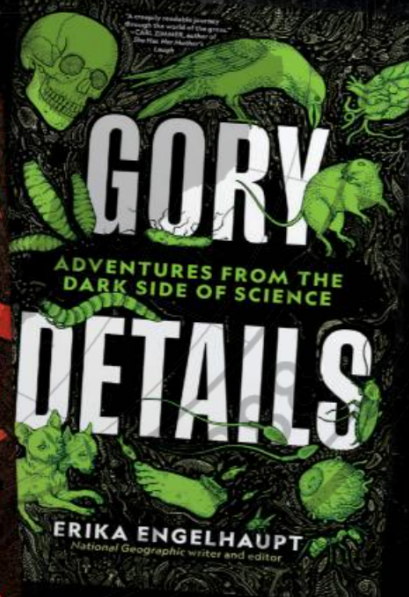
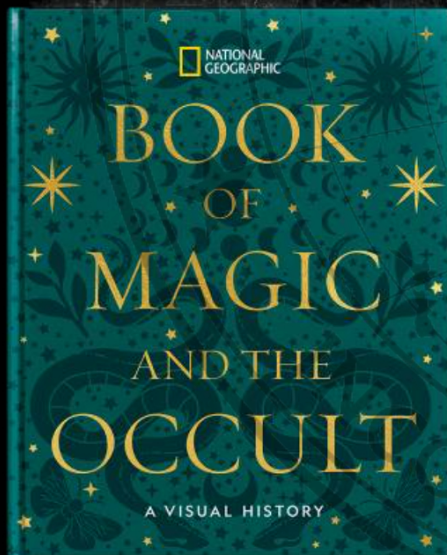
“I never expected
to be *tossed around*
in what felt like a
WASHING MACHINE
full of *crabs*.”

NICOLAS HAHN,
photographer

A legion of porcelain crabs
are tossed into a spin cycle,
swept off the seafloor by a
wave surge near central Chile's
Hualpén Peninsula. When
the current calmed, they
were clinging to Hahn's mask,
regulator, and camera lens.



FROM OCCULT SECRETS TO THE DEPTHS OF HELL



AVAILABLE WHEREVER BOOKS ARE SOLD

  NatGeoBooks

© 2025 National Geographic Partners, LLC

 NATIONAL GEOGRAPHIC

CONTRIBUTORS

NATIONAL GEOGRAPHIC EXPLORERS

These contributors have received funding from the National Geographic Society, which is committed to illuminating and protecting the wonder of our world. Learn more about the Society's support of Explorers at natgeo.com/impact.



Babak Tafreshi, p. 112

The Boston-based Explorer visited four continents for this month's feature pairing his photographs with those made by astronaut Don Pettit from aboard the International Space Station. He is a past winner of the Royal Photographic Society's Award for Scientific Imaging.



Prasenjeet Yadav, p. 16

An Explorer since 2014, Yadav spent nearly 14 months reporting and photographing this issue's story on efforts to preserve genetic diversity in India's tiger reserves. For his last *National Geographic* assignment, he captured incredible images of snow leopards in the Indian Himalaya.



Marina Koren, p. 112

A former *Atlantic* staff writer, Koren says her beat is "all things space," including astronomical discoveries and human spaceflight. She wrote this month about Don Pettit and Babak Tafreshi's project pairing photos made in orbit with terrestrial ones. The assignment reminded her, Koren says, "that the cosmos is a physical place we inhabit."



Paola Kudacki, p. 40

Photographing iconic sports stars for the magazine's feature on what we can learn from aging athletes was a privilege, Kudacki says, as she has long been "intrigued by what drives someone to become great." The New York-based portrait photographer has shot for publications like *Time*, the *New York Times*, *Vogue*, and *GQ*.



Neha Wadekar, p. 100

The writer divides her time between London and Nairobi, where she reported the story on Kenya's only ice hockey team. She's also written for the *New Yorker*, the *New York Times*, and the *Economist*, and her reporting on jihadi insurgency in Mozambique earned the Pulitzer Center's Breakthrough Journalism Award.



Matt Griffin, p. 36

Based in Ennis, Ireland, the sci-fi and fantasy illustrator depicted a dozen retro satellites for this month's story on the historic value of space relics. Griffin has created art for special editions of titles by Frank Herbert and Arthur C. Clarke. In his last piece for the magazine, he illustrated a real-life, Cold War nuclear base hidden beneath a glacier.

A tiger with orange and black stripes is walking through a dense, green forest. The tiger is positioned on the right side of the frame, moving towards the left. The background is filled with thick foliage and trees, creating a sense of a wild, natural habitat. The lighting is soft, filtering through the leaves.

THE CURIOUS CASE OF THE TIGERS WHO CHANGED THEIR STRIPES

A century ago, India's tigers were on the brink of extinction. Slowly, their numbers have rebounded. But that ecological success has prompted a dire new problem—and a race to save many of them from genetic collapse.

**WORDS AND PHOTOGRAPHS BY
PRASENJEET YADAV**

A black tiger with orange stripes is walking through a forest. The tiger is in the lower half of the frame, facing right. The background is a dense forest with a large tree trunk visible behind the tiger. The lighting is natural, suggesting daylight. The tiger's coat is predominantly black with distinct orange stripes and white markings on its face and underbelly.

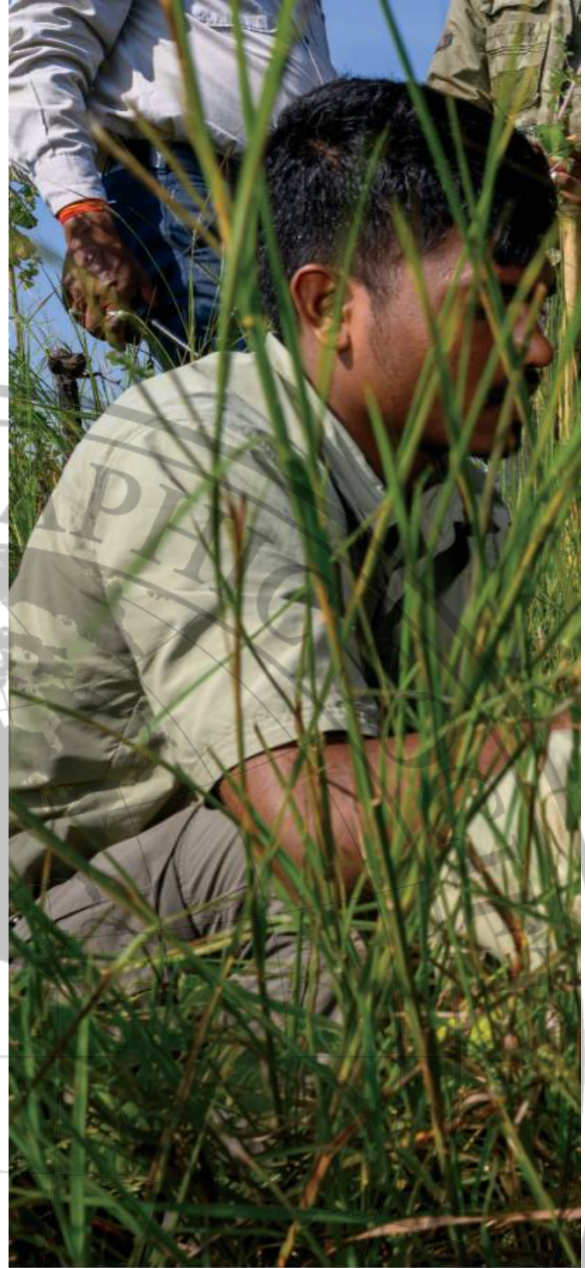
In 2014 just four tigers remained in India's Similipal Tiger Reserve. The only male, T12 (pictured), was born with a rare genetic mutation that left him with a predominantly black coat. As T12 helped repopulate Similipal, his dark coat showed up in his offspring—raising serious concerns over inbreeding.



IT TOOK 50 DAYS of searching before the jungle revealed its biggest secret to us. Fifty days of jostling along gravel roads in the Similipal Tiger Reserve, in India's eastern state of Odisha, scanning between trees in the semi-evergreen forest, hoping for a glimpse of an elusive tiger called T12, whose striking appearance has made him a symbol of a population at a perilous crossroads.

My partner in the quest, Raghu Purti, a staffer with the regional forest department, had never set eyes on T12. Most of his colleagues had only ever seen the tiger in images from camera traps set up to study animal movements throughout the reserve. But actually laying eyes on Similipal's tigers lets forest officials look for physical ailments that cameras may not capture—and also provides a reminder that there's a living, breathing purpose to the countless hours they spend patrolling in the sweltering heat. A documented sighting of T12 would be particularly valuable, since the reclusive 10-year-old tiger—the eldest male in Similipal—was right then at the heart of a plan to ensure the survival of future generations.

It was late in the afternoon of day 50 when, in the blink of an eye, a dark shape dashed out in front of our pickup truck. I slammed on the brakes. Ahead of us, spanning the width of the road, an enormous tiger stared back at Raghu and me. It was an older



 The nonprofit National Geographic Society, committed to illuminating and protecting the wonder of our world, funded National Geographic Explorer and photographer Prasenjeet Yadav's work.



Similipal has the potential to be a tiger haven—if forest managers can solve the inbreeding issue. With genetic researchers, they identified promising female mates in the district of Chandrapur. Jamuna was the first to be tranquilized and translocated.

male—clear from its size—and it had exactly the strange, distinctive coat we'd been looking for.

"It's black," Raghu said, in an insistent whisper. He pointed excitedly and repeated himself. "It's black!"

The tiger, T12, had dark fur that draped over him like a ragged cloak. Slivers of orange peeked through along his body, with thicker patches appearing on his face and front legs. This uncanny widening of a tiger's black stripes, a rare genetic mutation known as pseudo-melanism,

is shared among roughly half the 30 or so tigers that roam the Similipal reserve. And it's an indicator of a conservation success story facing a potentially catastrophic complication. Because while the number of tigers in Similipal is more robust than it has been in decades, the reserve is geographically isolated from other tiger populations—a tiger island, so to speak, with a dangerously dwindling gene pool.

But during the weeks that Raghu and I scoured the area for T12, work was under way elsewhere to find him a suitable mate. It was a crucial step in a targeted breeding program years in development, a mission shared between conservation agents and a team of groundbreaking molecular ecologists and genetic

experts all working to save the tigers of Similipal from inbreeding themselves out of existence.

In many ways, India's tigers have faced the same challenges as big cats throughout the world have, hunted to near extinction by trophy hunters amid relentless habitat destruction and fragmentation. In the 1970s alarm over the iconic species' decline prompted the establishment of a state-run reserve system. But the reserves lacked coordinated monitoring and enforcement until 2005, when India created a dedicated central agency, the National Tiger Conservation Authority (NTCA), which today hires and trains rangers, manages scientific oversight, and guides habitat preservation across 58 reserves.

A key concept underlying the reserve system is that tigers are typically able to travel between protected areas using what are known as natural corridors—patches of connecting forest and other prey-abundant lands. There are a number of benefits to these corridors, but the most important is that they encourage breeding among neighboring tiger populations, improving genetic diversity. Similipal, at a little over a thousand square miles, is one of India's largest reserves, and its closest neighboring ones—Satkosia to the southwest and Sundarban to the east—are both more than a hundred miles away, which isn't too far for a tiger to walk.

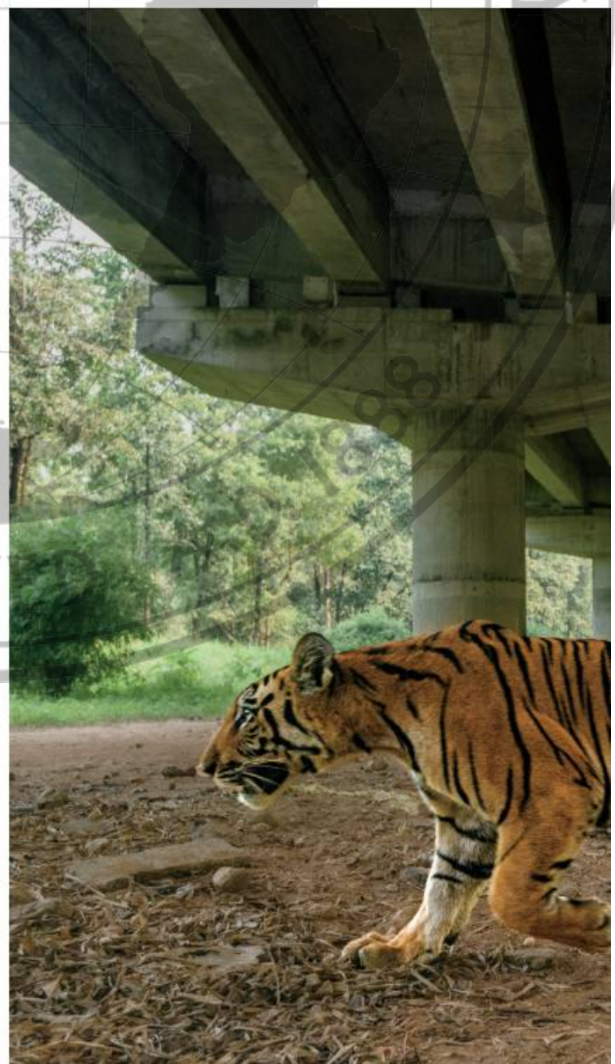
But there are no tigers left in Satkosia. And no adequate corridor connects Similipal and Sundarban. The land between them is mostly urban or agricultural—Kolkata, its suburbs, and a vast area of rice fields—with very little forest cover, which is where tigers prefer to stay hidden. Dozens of towns and villages separate Similipal from its two neighboring reserves as well. For tigers, there is just no easy way in or out of Similipal.

When the NTCA surveyed wild tigers across India in 2006, the tally was roughly 1,400 animals—down from an estimated 40,000 a century before. In Similipal, the population bottomed out at just four tigers, in 2014, only one of them male. But in 2015, a year or so before he died, the male fathered T12, with his strange, predominantly black coat. And T12 has since fathered male cubs of his own.

India's tiger population has begun to rebound over the past 20 years, thanks in large part to the conservation work of the NTCA and forest officials. As of a 2022 estimate, the country is home to more than 3,100

tigers. And as Similipal's population climbed slowly but steadily over the past decade, the growing number of tigers at first seemed like a microcosm of the national success story. Soon, though, the reserve's managers began noticing more and more young tigers sporting the same dark coat as T12. The mutation, as far as both foresters and genetic scientists can tell, is harmless, merely a cosmetic oddity caused by a random and naturally occurring quirk of DNA.

But, experts say, it is also a tangible manifestation of a very real problem. If this mutation was able to pass so quickly through Similipal's population, with all the tigers sharing very similar genetic makeup due to rampant inbreeding, then so too could more serious abnormalities. Now the





In the past century, deforestation and development have fragmented habitats and severed natural corridors that enabled breeding between tiger populations. Some reserves have maintained or restored these corridors, while others remain cut off.

To encourage a steady flow among tiger populations, India has constructed elevated highways and wildlife underpasses, such as this one between the Pench and Kanha tiger reserves. Here, two tigers cautiously cross underneath National Highway 44 (also pictured above).

A tiger relocation is approved only when the donor population can withstand losing a breeding-age female. That poses no risk in Chandrapur, where the number of tigers is booming and the big cats regularly leave the reserve in search of prey. Sometimes that means livestock.





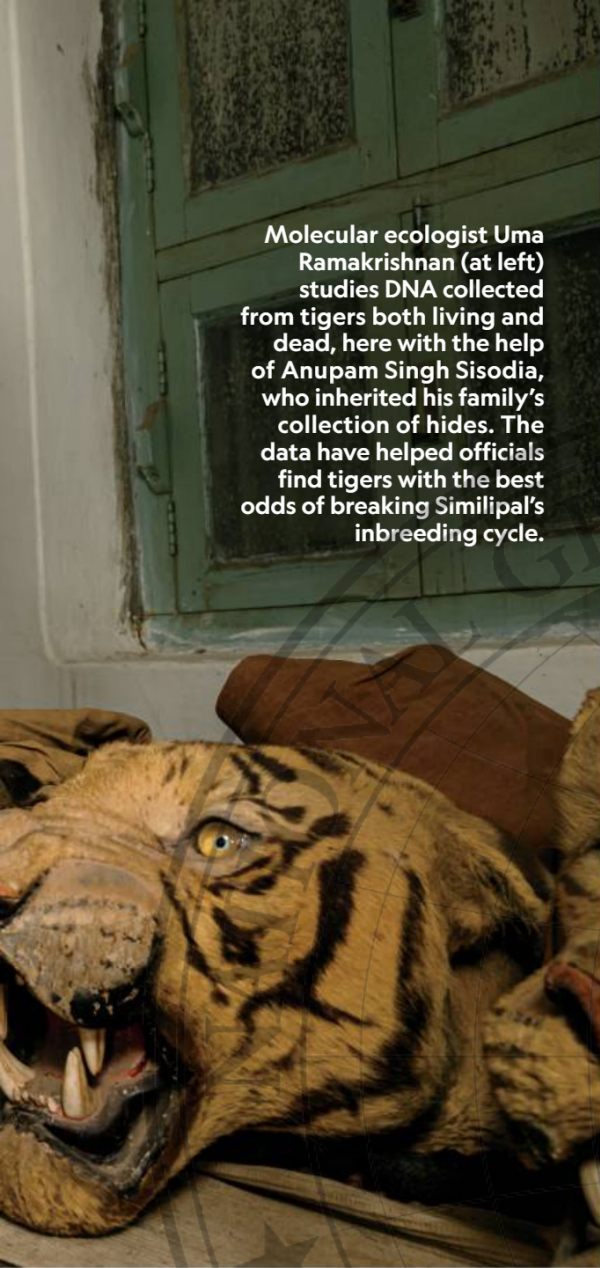


task facing some of India's foremost tiger authorities has shifted from recovering tiger numbers to breaking this cycle of inbreeding before it's too late.

P LAYING GENETIC MATCHMAKER for tigers is tricky. In order to find the ideal breeding partners for T12 and his offspring, the would-be saviors of Similipal needed to understand the differences among not only the tigers that roam today but also the tigers of the past.

That's what led molecular ecologist Uma Ramakrishnan, not long ago, into a dimly lit trophy room in a grand home in Akaltara, a small town in central

India. Ramakrishnan, a National Geographic Explorer and the head of a lab at Bengaluru's (Bangalore) National Centre for Biological Sciences, was invited there by Anupam Singh Sisodia, whose family had once held the role of chieftains across 51 villages and the surrounding forests and farmland, responsible for protecting the locals from dangerous wildlife. His family had done its share of hunting, and the room was full of mounted black bucks, sloth bears, and four-horned antelope collected



Molecular ecologist Uma Ramakrishnan (at left) studies DNA collected from tigers both living and dead, here with the help of Anupam Singh Sisodia, who inherited his family's collection of hides. The data have helped officials find tigers with the best odds of breaking Similipal's inbreeding cycle.

between 1920 and 1970. But laid out on a table before Ramakrishnan was a set of tiger pelts, their massive heads intact and seemingly snarling.

"Killing problematic tigers," Sisodia acknowledged, "was more of a political necessity than a pleasure."

Since 2005, Ramakrishnan and her fellow researchers and students at the lab have been collecting samples of tiger DNA in order to build an extensive genetic map of the diversity among India's tigers. She's secured roughly 250 specimens from

historic estates like the Sisodias'. She has plumbed taxidermy collections at sites like the Natural History Museum in London and ventured into Indian jungles to procure scat, blood, hair, and saliva from live tigers. All that evidence has given her critical insight into how the animals have changed over generations as they moved throughout the region.

Closely inspecting one of the tiger heads, Ramakrishnan slid her scalpel into the 80-something-year-old pelt. Practiced and precise, she sliced off a small piece. She slid the sample into a vial and held it up.

"This is the real treasure," she said.

When Ramakrishnan first began building her DNA database, her goal was to answer questions about tigers that couldn't be answered by observing them in the field. As their population was decimated, tigers lost not only territory but also substantial genetic diversity. Historical DNA offered important clues about what else might exist within the gene pool.

Her research became ever more relevant in 2017 when the NTCA, alarmed by the dark-coated tigers in Similipal, asked her to formally study the reserve's tigers. The forest officials clearly saw that the impacts of the reserve's isolation were becoming measurable. They hoped Ramakrishnan could both verify the genetic culprit and help them find a solution.

Once she took a closer look at the animals sequestered within the reserve, Ramakrishnan quickly realized that the recessive pseudo-melanism gene was spreading through the population. The genetic isolation on display, she said, was a ticking time bomb—left unaddressed, it could prove devastating to the reserve's tigers.

It's impossible to know precisely what other maladies genetic mutations among big cats might introduce. But when Ramakrishnan and her colleagues analyzed a genetic mutation dataset for the closest available comparison—domestic cats—they found that these not-so-distant cousins faced issues like retinal atrophy, kidney disease, and hyperthyroidism. And with female tigers averaging litters of two to three cubs every two to three years, health issues can quickly and dramatically compound.

"We're still trying to understand the full impact of this inbreeding," she says. "But one thing's for sure—there's no upside to this kind of genetic erosion."

Given Similipal's lack of connection to other reserves,

Bringing Tigers Together

After being decimated by hunting and habitat destruction, India's tiger population has begun to recover in protected reserves. But in less connected areas like Similipal, sometimes called tiger islands, inbreeding has become an issue. For reserves like Tadoba-Andhari, interconnected habitats and wildlife corridors help diversify the population—and may offer a solution for tiger islands.

LANDSCAPE OF THE TIGER

Forests provide spaces for tigers to rest and breed, along with ample prey. Although agricultural lands interrupt forest cover, tigers can move across them between reserves. But highways and urban areas remain difficult barriers.

-  **Tiger reserve**
Human activity restricted
-  **Tiger corridor**
Habitat potentially linking protected areas
-  **Tiger connectivity**
Area conducive to tiger settlement or movement
-  **Other protected area**
Limited human activity
-  **Forest**
-  **Cropland**
-  **Urban area**
-  **Road**

N
40 mi
40 km

In central India there is more genetic variety in tiger populations, lowering the chances of inbreeding.



A THE BENEFITS OF LINKED RESERVES

In reserves with good connectivity like Tadoba, tigers roam hundreds of miles along corridors to find mates among neighboring populations.





B THE PITFALLS OF A TIGER ISLAND

Tigers in reserves with no populations to mix with have limited mating options; in Simlipal, this has led to the rapid increase of a coat-color mutation.

THE POWER OF MOVING TIGERS

Given Simlipal's isolation from linked reserves, forest officials have begun to translocate tigers 450 miles from Tadoba to the tiger island in eastern India.

MAP: CHRISTINE FELLEZN AND PATRICIA HEALY, NGM STAFF
SOURCES: NATIONAL TIGER CONSERVATION AUTHORITY; IUCN; OPENTREETMAP; ADITYA JOSHI, WILDLIFE CONSERVATION TRUST; UMA RAMAKRISHNAN, VINAY SAGAR, AND ABHINAV TYAGI, NATIONAL CENTRE FOR BIOLOGICAL SCIENCES, TIFR; PRASENJEET YADAV



In Chandrapur, prime tiger habitat abuts farms, towns, and cities. But natural corridors connecting the region's reserves offer tigers safer passage across the developed landscape, even as the number of tigers has swelled.



Ramakrishnan's recommendation was that wildlife managers identify a few tigers from a separate reserve and translocate them. Once in Similipal, the tigresses (the forest managers elected to move females) would hopefully reproduce with T12 or with his male offspring, which have begun to claim pieces of T12's territory as they mature and have cubs of their own. This, Ramakrishnan said, would begin the overdue effort to diversify the reserve's genetic pool. By comparing Similipal tiger DNA to the array of records in her dataset, she found that the most genetically diverse tigers with the lowest chance of more negative genes showing up in any future offspring were located in a reserve called Tadoba-Andhari, in the dense teak forests of the district of Chandrapur, halfway across India.

Of course, Ramakrishnan knew that identifying the right reserve is one thing. Actually moving a 300-pound wild animal hundreds of miles across the country is another.

ONE MORNING LAST fall, Ravikant Khobragade stood up from his spot in the open-air back seat of a two-door Maruti Gypsy and looked out onto the Chandrapur landscape. The wildlife veterinarian turned his attention to his ace shooter, Ajay Marathe, who was cradling a tranquilizer gun, and gestured to a young tigress just up ahead.

"I can see her. She is sitting in that bush ahead looking at us," Khobragade said.

The tigress, later named Jamuna, was 28 months old and had spent all her life in or near the Tadoba reserve. Her youth meant she hadn't yet established territory there. And, crucially, she had no history of conflict with humans. Both of these things made her a prime translocation candidate.

Translocation work, particularly for animals as large and territorial as tigers, is highly sensitive under any circumstances, and in India's tiger reserves, it requires a large number of verifications and approvals before it can proceed. High on the list of considerations is whether an area identified as having candidates has a population healthy enough to withstand losing breeding-age females. In Tadoba, this is not a concern.

Although the reserve is two-thirds the size of Similipal, it is home to roughly 95 tigers, and it is no



As the growing tiger population in Chandrapur drives the animals farther from the reserve, territorial fights sometimes result. This tiger was killed in a battle with a competing male. After a postmortem exam, the body was cremated.



tiger island: Natural corridors connect Tadoba to the Umred Karhandla Wildlife Sanctuary around 40 miles to the north, the Nawegaon-Nagzira Tiger Reserve 70 miles to the northeast, and the Kawal Tiger Reserve 70 miles to the southwest. Tadoba's tigers regularly venture out in search of more forested space. And as their numbers have swelled over the past decade, all that movement has meant that tigers and people in the surrounding mosaic of forests, villages, and farmlands have had to learn how to live alongside one another again. Most important for T12 and his kin, the network of connected reserves has allowed for a constant exchange of tiger genes.

Jamuna would be the first of two Tadoba tigers translocated to Similipal in a matter of weeks, with others to potentially follow in the coming months and years if the experiment went well. But first, she needed to be sedated.

"Is the dart ready, sir?" asked Marathe.

The tigress rose from her spot in the bush and marched closer to their vehicle. When she was around five yards away, Marathe calmly removed the safety key from his dart gun, brought the scope to his eye, and took the shot. The pink-tailed projectile landed in Jamuna's thigh, prompting a loud growl that echoed across the landscape as she bounded away. She made it about 200 yards before the tranquilizer took its toll. The team found her laid out in a meadow.

It took seven men to carefully slide Jamuna onto a stretcher and move her into the shade. Khobragade checked her for injuries and drew a blood sample. After he fixed a GPS collar around her neck, the team moved her into a metal cage aboard a truck. Once safely inside, Jamuna was given a revival drug. Within minutes, the men heard rustling and banging, the sound of her nails scratching against metal, followed by a roar.

The road trip to deliver Jamuna to Similipal took 28 hours. The truck was joined by a small convoy of support staff. The route had been carefully mapped to circumvent major cities and other areas where loud noises could cause Jamuna distress. Every few hours, the vehicles pulled over for a while to allow her to rest.

Finally, the door opened and Jamuna leaped through the gate leading into her new home, a two-and-a-half-acre enclosure in Similipal, where she spent almost two weeks acclimating. After that, the

gate opened once more, this time with no cage on the other side. She was set free into the territory of T12.

WHEN IT COMES to restoring diversity among India's wild tigers, one critical step remains solely under nature's control: mating. And tigers engage in selective courtships before they breed.

So in November, less than a month after Jamuna was released into the reserve, a second female tiger from Tadoba, called Zeenat, was sedated and transferred to an enclosure in Similipal. Whereas Jamuna settled in the Similipal landscape with relative ease, the stress of the relocation took a greater toll on Zeenat, and she quickly wandered beyond the reserve's borders. The forest department, not wanting her to stray too far, sent a team out to tranquilize her and bring her back to spend several more weeks in an enclosure to acclimate before she was released into T12's territory.

Both she and Jamuna wore GPS collars so that forest officials could track their movement and behavior. Knowing where the tigers were, forest officers on the ground used night vision cameras to observe them from a safe distance. They kept a close eye on the pair to see whether either of them would cross paths with T12 or other males.

But the observers only saw Jamuna and Zeenat alone. Tiger courtship, by contrast, is conspicuous. A pair of mating tigers might spend weeks together, walking through the forest and vocalizing. Yet as the tigresses established territory in Similipal,

forest officials never saw any evidence that they'd so much as had contact with T12.

Until one night in May. Reviewing the feed from a mounted camera that takes thermal and visual images, the forest department captured footage of Zeenat with T12. It was unmistakable evidence: Their mating ritual had begun.

The courtship sighting signaled that the genetic rescue mission, if not yet an outright success, holds promise. Meanwhile, this summer, as the teams behind the translocation awaited Zeenat's first litter of cubs, the work continued. Ramakrishnan and her students collected more hair and scat samples left behind by Similipal tigers to better understand the genetic variation within the population. Officials are hopeful that Jamuna will eventually find a mate. And everyone working in Similipal is eager to see whether Zeenat's cubs are born with T12's pseudo-melanism.

It's not yet decided whether or when the reserve will receive more translocated tigresses—or how many more might be needed to introduce sufficient genetic variability. But until a corridor links Similipal to other populated tiger reserves, more translocations could be the only viable option. Looking ahead, Similipal field director Prakash Chand Gogineni said his personal hope is that Similipal's tigers can become a source population that helps return the species to places like the nearby Satkosia reserve. That might happen with the help of a translocated Similipal tigress or perhaps via new corridors, even if the latter are still likely decades away.

Witnessing all of this firsthand, seeing the pitfalls that India's tigers face as they begin to make their

**'WE'RE STILL TRYING
TO UNDERSTAND
THE FULL IMPACT OF THIS
INBREEDING,' UMA
RAMAKRISHNAN SAYS.
'BUT ONE THING'S FOR
SURE—THERE'S NO UPSIDE
TO THIS KIND OF
GENETIC EROSION.'**

comeback, returns me to certain moments from my childhood. I grew up on a farm not far from Chandrapur, where my life revolved around animals and jungles, for better and for worse. Naming pet dogs was painful, as leopards regularly took them away. And every now and then we would encounter a pugmark similar to a leopard's but much bigger. The air would fill with fear and excitement at the realization we were sharing space with a true apex predator. The experience of living alongside something that powerful and elusive shaped how I saw the forest and my place within it. I never came across a tiger at our farm. But I often dreamed of it.

In the years since, I have seen, studied, and photographed countless tigers. But none of them looked like what I saw that day in Similipal while sitting in the idling truck with Raghu. Locked in a momentary staring contest with T12, I didn't reach for my camera. I didn't move. There stood a black tiger, a testament to humans' best intentions gone wrong. In the best-case scenario for Similipal, this will someday be a rare and unforgettable creature. One that inspired a new discipline for safeguarding the species. In that moment, for four seconds in the roadway, it felt like a miracle of nature. Then, without a roar or a snarl, T12 took a few powerful strides and vanished into the thick evergreen forest. □

Jamuna was the first of two female tigers moved from a reserve in Chandrapur to Similipal, where she was released into an enclosure to acclimate. Officials hope the two will mate with Similipal's males and produce a more genetically diverse generation of tigers.





CHARTED

Can we SAVE the ORBITING TREASURES of the SPACE RACE?

As human-made objects proliferate in space, a coalition of scientists and historians have floated retrieving some of the most important.

Words by BRIAN KEVIN

Illustrations by MATT GRIFFIN

→ **IN ONE VIEW**, Vanguard 1 is space junk: an antennae aluminum ball that Soviet leader Nikita Khrushchev dismissively compared to a grapefruit. The United States launched it in March 1958, and the satellite returned radio signals until May 1964. Defunct since, it's the oldest human-made object in orbit.

But to space historian Matt Bille, that grapefruit is "one of the most precious objects" of the early space age, deserving of a place in the Smithsonian. And scientists, he says, could glean much from it about long-term exposure to space. Bille, along with a few like-minded engineers and historians, made this case at a recent conference of the American Institute of Aeronautics and Astronautics, presenting detailed plans for a hypothetical mission to deorbit Vanguard 1 and bring it home.

The idea has turned heads, not least for challenging a preference for in situ preservation that's increasingly enshrined in heritage fields, including the burgeoning discipline of space archaeology. Old satellites "need to be left where they are," says Alice Gorman, who sits on the International Council on Monuments and Sites' aerospace committee. They're safer in orbit, she says, where they belong to no one nation and can be studied via photography and other remote sensing methods.

But space is getting crowded, Bille notes—more than 14,000 satellites orbit the Earth, to say nothing of debris. He and his co-authors frame their technical paper as a thought experiment: Should we ever consider nabbing historically significant satellites? Which might merit consideration? They offer 11 more candidates, each a national first or a pioneering mission, and all conceivably retrievable, Bille says, if one dreams big.

VANGUARD 1

U.S. • Launched on March 17, 1958
Low Earth orbit

The second U.S. satellite in orbit (the first, Explorer 1, burned up upon reentry in 1970), its most distinguished contribution was to confirm, via variations in its orbit, that Earth was less round than supposed, bulging around the Equator.

LUNA 1

U.S.S.R. • January 2, 1959
Solar orbit

A yoga ball to Vanguard 1's grapefruit and the first spacecraft to escape Earth's gravity. The Soviets aimed for the moon and missed by some 3,700 miles. Luna 1 became, instead, the first spacecraft to settle into orbit around the sun.

PIONEER 4

U.S. • March 3, 1959
Solar orbit

Like Luna 1, the first American craft to travel beyond Earth's orbit also blew its objective, passing too far from the moon to photograph it as planned. It returned good data, though, on the Earth's encircling radiation belts.

TELSTAR

U.S. • July 10, 1962
Low Earth orbit

The first ever active communications satellite sporadically relayed TV images across the Atlantic until, as space historian Matt Bille puts it, "we sort of killed it by accident." Radiation from a high-altitude nuclear test knocked it out after seven months.

TIROS 1

U.S. • April 1, 1960
Low Earth orbit

Today we take weather-observation satellites for granted, but when NASA sent up its first attempt at one—"a flying ladies' hatbox," as one newsreel called TIROS 1—just how useful it would be for forecasting was still an open question.

V
U.S.
Hic
Fr
Th
up
the
Tre
ex
to

ALOUETTE 1

Canada • September 29, 1962
Low Earth orbit

Canada became the third nation in space with this workhorse, which sent back some two million data snapshots of the ionosphere—the atmospheric layer that reflects radio waves—during a record-setting 10 years in operation.

EARLY BIRD

U.S. • April 6, 1965
Geostationary orbit

It was the first commercial communications satellite in a stationary orbit, and staying put over its coverage area permitted uninterrupted transmission. Cable TV viewers in the 1980s or '90s can thank geostationary satellites that followed Early Bird's lead.

PIONEER 6

U.S. • December 16, 1965
Solar orbit

"We were gearing up to go to the moon," Bille says, "and we wanted some idea of what conditions were like in interplanetary space." The first probe to study things like solar wind and the interplanetary magnetic field, it fed data to NASA into the '90s.

ASTÉRIX

France • November 26, 1965
Low Earth orbit

France's first foray into orbit—and the first satellite named for a comic-book character, a pint-size Gaulish warrior—was damaged upon ejection from its rocket and transmitted no or next to no data.

VEGA

U.S.S.R. • December 15, 1984
Solar orbit

Scientists cooperated across Cold War lines on a mission that sent this massive satellite on a journey that included a Venus flyby and a pass through the gas cloud surrounding Halley's comet.

VELA 1A AND B

U.S. • October 17, 1963
High Earth orbit

From the Spanish *vela*: to watch. Its pair of polyhedrons went into orbit weeks after the U.S. ratified the Limited Nuclear Test Ban Treaty, designed to detect nuclear explosions and work together to triangulate their location.

SATELLITES SHOWN TO SCALE

GRAPHIC: BRIAN KEVIN AND JASON TREAT
NGM STAFF. ILLUSTRATIONS: MATT GRIFFIN
SOURCES: MATT BILLE; NASA



OLD BEFORE IT'S A STRO



In evolutionary terms, humans are pretty new at getting old. Since 1900, we've managed to increase our life expectancy, from 47 to 78, even though we're only just now beginning to understand the science of longevity—and what exactly human beings are capable of as we live deeper, and healthier, into our 70s, 80s, 90s, even 100s. To help you harness all that we're learning about how to age athletically, *National Geographic* found **a handful of people hitting their stride in the last leg of their lives.** We also share some pointers about **how to start extending your health span right now**, no matter how old you are, and **some wisdom—pep talks, really—from four of the greatest athletic specimens of the 20th century.**

DEEP TERRA NIGER

GROWING
OLDER,
GROWING
FITTER
PAGE 42

EXTENDING
YOUR
HEALTH SPAN
PAGE 60

LEARNING
FROM
THE LEGENDS
PAGE 64



WORDS BY
CHRIS BALLARD

PHOTOGRAPHS BY
ALEX LAU

HOW TO AGE LIKE AN ATHLETE

An increasing body of research is telling us that staying active as we age provides extraordinary health benefits. These over-50 champs offer proof of what we gain by being athletes later in our lives.

FOR NORA LANGDON, the moment of truth came on the stairs. She was 64 years old. Up to that point, Langdon had lived a largely satisfying life. She'd raised two kids, had good friends, and was in her third decade as a real estate agent in the Detroit area.

But as time went by, she'd gained weight, slowly at first, until suddenly she hit 220 pounds. She'd never been an athlete—never played sports, hit the gym, or exercised consistently—but she wasn't a couch potato either. Her dad had worked in a steel factory, waking the kids at 5 a.m. for prayer and breakfast, and at night they all helped with the family's soul food catering business. In her world, effort had always mattered. And yet

here she was, struggling to make it to the second floor while showing houses to potential buyers.

She began to worry. She'd seen retirees fall prey to a sedentary lifestyle. "Ten years later, they're gone because they don't do anything but go home and eat, eat, sit down, and look at the TV," she says. "I saw a lot of my friends pass away because they weren't strong enough." She wanted no part of it. "I said, No, I'm not going out like that."

At her birthday party, she got to talking with a friend's husband by the name of Art Little. Wiry, enthusiastic, and no-nonsense, he worked as a trainer at a gym for powerlifters north of Detroit. He invited her to come in for a workout. Langdon wasn't sure; she'd never done any weight lifting and had always considered herself "a weakling." When Langdon showed up, Little led her to a bench. Around them, thick-necked men grunted. Weights clattered. Little instructed Langdon to lie down, then lowered a broomstick into her hands. It weighed less than three pounds. Up and down she went with it, fighting gravity the whole way.

That night, she returned home exhausted. Her body ached everywhere, years of disuse coming to bear. She was reluctant to return, but a little voice in her head

told her she couldn't quit—not after one session. So she went back to Little's gym later that week and then the week after. Little pushed her to add weight—from broomstick to empty barbell, then to the bar with plates. Each time, she told him she couldn't do it. "Just try it," Little responded. She did, finding she loved the feeling of getting stronger. Soon enough, with Little's encouragement, she entered powerlifting competitions and began collecting gold medals in her age-group, even some for bench press—a long way from her first session. Now in her ninth decade, she is stronger than most women in their 20s and 30s.

Langdon is not alone. More people are not only exercising longer and later in life—they're also competing and breaking records in a range of sports. In Pennsylvania, a computer programmer took up running again in his 50s and now holds the fastest marathon time for a 70-plus runner. In Idaho, a mountain biker racked up world championships while discovering that prioritizing mental health rekindled her love for the sport—and helped her stay sharp. And in Ireland, after a string of injuries, a former rugby player learned that finding the right sport for a changing body sometimes takes persistence. Today he's the Guinness World Record holder for being the first man to swim a mile in ice-cold water on all seven continents.

These athletes are remarkable examples of a broad but quiet revolution in how we understand human potential across a person's lifetime. Hirofumi Tanaka, a leading researcher on exercise and longevity, views "masters" athletes—typically

those hardy souls who keep competing beyond the age of 35—as a compelling model of what he calls "exceptionally successful aging," thanks to their ability to preserve strength, endurance, and cardiovascular health well into later life.

"It's really staggering," says Tanaka, director of the Cardiovascular Aging Research Laboratory at the University of Texas at Austin. "If you look at the world record [for any given sport], that's basically stagnated. They haven't changed that much over the last 10 or 20 years." But age-group records, he says, are a different story. "They are improving rapidly."

These athletes aren't just aging well; they're redefining what aging can look like. Longevity is one thing,

• **LIMITLESS: LIVE BETTER NOW**



The second season of *Limitless* is streaming on Disney+. Check local listings.

Three years ago, Chris Hemsworth embarked on *Limitless*, a National Geographic series that invited audiences to follow along on the actor's globe-spanning quest to unlock some

of the secrets for living a longer and more fulfilling life. Now he's returned with another season that dives deeper into what science can teach us about how to improve our physical health and

mental well-being today. His journey prompted us to take a closer look at what scientists are learning about aging athletes—and how we might apply a wealth of new insights to our own lives.

quality of life is another. In recent decades, scientists have turned their attention to lengthening the stretch of life spent active, healthy, and engaged, called health span. The goal is no longer just to extend life but to expand the years you can truly live well.

While diet matters, of course, and medicine and genetics play a role, exercise is the linchpin when it comes to health span. It improves heart health, lowers the risk of cancer, increases bone density, aids in cognition, reduces the prevalence and impact of Alzheimer's, and decreases symptoms of depression. A 2024 longitudinal study in *Circulation* found that logging 300 minutes of moderate weekly exercise, or 150 minutes of intense activity, can lower mortality risk by roughly 30 percent. By another measure, every minute you exercise adds five minutes to your life.

Across these pages, we highlight a handful of record-setting athletes from their 50s to their 80s. Each extraordinary competitor provides insight into the lessons and emerging science of aging athletes—and gives us all something to strive for.



→ **NORA LANGDON, 82**

The retired Michigan real estate agent started powerlifting in her 60s and quickly got hooked. Over the past two decades, she's set more than 20 world and national age-group records.

THE POWERFUL IMPACT OF WEIGHT TRAINING

Only a few months into her new life at the gym, back in 2006, Nora Langdon was already feeling the benefits. She was becoming steadier on her feet, stronger through the core, and more confident under the bar.

Like many older adults, Langdon likely experienced sarcopenia—the age-related loss of muscle mass that accelerates with inactivity. Sarcopenia can lead to a host of negative outcomes: reduced mobility,

increased danger of falls, a lack of independence. The good news: Lifting helps counteract those effects. A 2024 study published in the *Journal of the American College of Cardiology* found women who do strength training are more likely to live longer and have a lower risk of death from heart disease compared with women who don't. Those who participate in strength-based exercises had a 19 percent reduction in mortality risk from any cause and a 30 percent reduction in mortality risk from heart-related conditions—and the benefits for women are even more pronounced than for men.

In Langdon's case, she steadily lost body weight, dropping almost 20 pounds, but also gained muscle. Within months, she was pushing around enough weight that Little suggested she enter her first state powerlifting tournament. When Langdon arrived, she was in awe of all the strong women—most of them much younger than she was. Then she got under the bar. To her shock, she took home the women's 60-69 age-group gold in all three events she entered, squatting 190 pounds, bench-pressing 95, and deadlifting 250.

After another year of training, Langdon advanced to the nationals and then to the 2008 World Championships in Palm Springs,



California, where she squatted 330 pounds and won her age-group's gold medal. Since then, she has set more than 20 national and world age-group records, logging personal records (PRs) of 203 pounds in the bench press, 381 pounds in the dead lift, and 413 pounds in the squat—a mark she set in her 70s. (Her bench press and dead lift PRs remain U.S. records in the 70s age-group.)

Now 82, Langdon still trains religiously, three days a week, for three to four hours, usually wearing Converse high-tops and eschewing headphones to better focus on the task at hand. She drinks protein shakes on the days she trains, eats beef twice a week, and swears by an elixir of a tablespoon of apple cider vinegar in a half glass of water. “All I want to do is inspire other people just to get up and do things,” she says.

But the challenge for most is getting started; the Centers for Disease Control and Prevention found only 7 percent of American adults do strength training three times a week. If they can make the leap to take up weight training, the effects begin to compound: A study in the *Scandinavian Journal of Medicine & Science in Sports* found older people gain not only muscle mass but also confidence and motivation.

Langdon says she feels as

if she keeps getting stronger, even at her age. And she has no plans of stopping, either. Not until, as she puts it, “the

Lord tells me to go on my own.” In the meantime, she’ll be in the weight room three times a week, without fail.





Langdon started out struggling to push up a broomstick. A year later, at age 65, she entered the World Masters Powerlifting Competition in Palm Springs, California, pictured at left in the framed photo, where she deadlifted 336 pounds.



**'ALL I WANT TO DO
IS INSPIRE OTHER
PEOPLE JUST TO GET UP
AND DO THINGS.'**



STARTING LATE CAN HELP YOU FINISH STRONGER

When Gene “Ultra Geezer” Dykes revived a long-dormant athletic passion, he discovered his delayed commitment to competitive running might be a secret weapon.

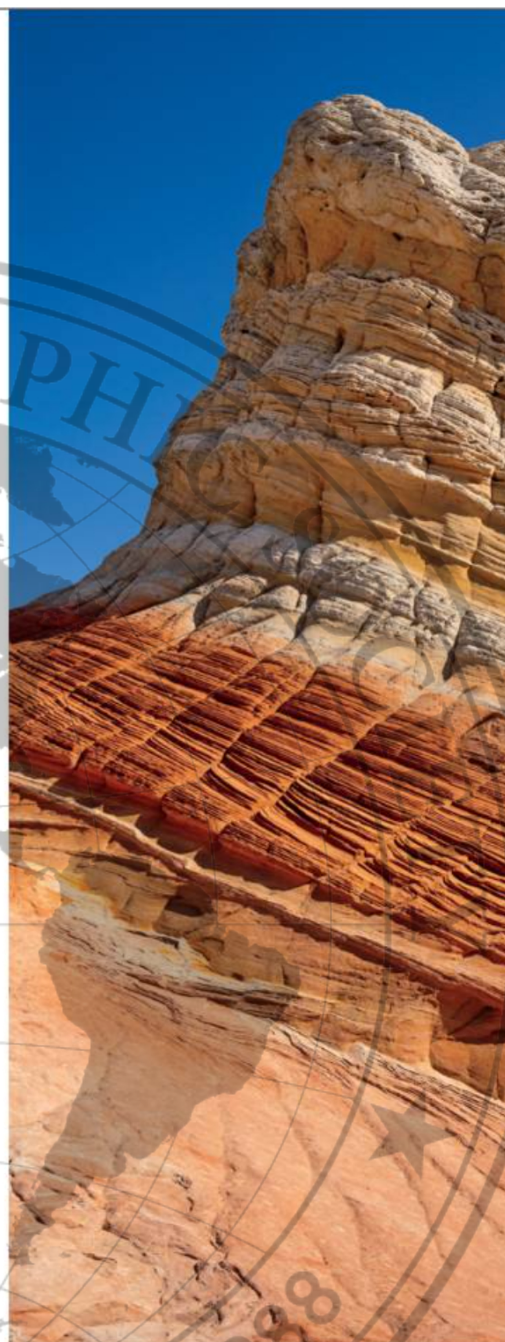
Dykes grew up in Canton, Ohio, and ran in school, then drifted away from the sport. He became a father to two daughters, took up golf and bowling, and focused on his job as a computer programmer. When Dykes was in his early 50s, a friend recommended that he join a running group in the Philly suburbs, where he lives. Soon the group persuaded Dykes to enter races, including a half-marathon. He loved the competitiveness of road racing, and had a blast running trails. In November 2006, at age 58, he lined up alongside more than 35,000 other

qualifiers on a cool day in Staten Island at the start of the New York City Marathon. Not only did he finish, but he did so in under four hours.

Immediately, Dykes wanted more. With his kids grown and retirement lined up, he put down the five iron and began running—a lot. He ran with friends, with his daughter, by himself.

Over the ensuing two decades, Dykes—a slight man with an ever-present smile—ran thousands upon thousands of miles, setting age-group records in everything from 8Ks to marathons to 50Ks. He won his age-group nearly every time he competed in the Boston Marathon. At 69, he survived the sun-scorched, 240-mile Moab Endurance run in Utah, a giant loop covering desert, canyons, rocky slopes, and two mountain ranges. Defying reason, the Ultra Geezer—a name bestowed by his daughter—got faster as

he aged. In 2018, at age 70, he ran a 2:54:23 marathon, not only the fastest ever by a 70-plus runner but also a full 10 minutes faster than his PR of a year earlier. At 75, he broke seven masters records during a solo





12-hour race at Pennsylvania's Dawn to Dusk to Dawn Track Ultras.

How did Dykes do it? His late-life surge may be telling. We've long been told to use it or lose it, but Dykes's case provides a counterpoint. "We

tend to think they're lifelong athletes," researcher Hirofumi Tanaka says of elite masters performers. "But they're not. Many of them actually started competing after they retired."

How and why is the focus of one of Tanaka's current studies. For the past five years, he and his team have set up a testing station at the World Masters Athletic Championships—most recently in Gainesville, Florida—to compile data from competitors. Each year, they release new data on associated medical trends, and Tanaka's next paper, for which the team is still analyzing data, specifically looks at the tread on our physiological tires. Tanaka's hypothesis: Some younger athletes go so hard that they develop osteoarthritis and other conditions that keep them from competing later in life. "But those people who remain sedentary when they're younger, they preserve their joints, they preserve their ligaments, and now they can blossom as an athlete."

Dykes believes this to be the case. He recommends that you "save your money and your legs for retirement." Looking back, he believes the whirl of professional life and fatherhood may have been the best thing that ever happened to him. "It made me delay my hard running until I was



→ GENE DYKES, 77

The former computer programmer in Pennsylvania rekindled his passion for running in his 50s. Since then, he has set age-group records in 8K races, marathons, 50Ks, and 100Ks.

older," he says. "I tell people, 'You young guys, you're competing against Olympic hopefuls. I'm competing against people six feet under. It's a lot easier. It was a blessing in disguise.'"

While Dykes started late, he also operates at a different level than his age-group peers—not to mention plenty of runners decades younger. After Dykes's record-setting 2018 marathon performance, researchers at the University of Delaware tested his physical markers, including his body composition, the economy of his running pace, and the volume of oxygen he could process per minute based on his weight, known

as VO₂ max. This is a key measure of aerobic fitness that reflects how efficiently the body uses oxygen during intense exercise. (It was, Dykes says, the first time he'd run on a treadmill and, he vows, the last.)

They found that Dykes's VO₂ max of 46.9 milliliters was nearly double the average for a typical 71-year-old, and was far higher than that of most marathon runners regardless of age. According to the Delaware researchers, who published their findings in the *New England Journal of Medicine*, most marathoners maintain 75 to 85 percent of their maximum oxygen uptake; Dykes performed at 93 percent. As you might imagine, these markers are closely tied to health span: VO₂ max is not only one of the best indicators of overall fitness, but is also one of the strongest predictors of longevity. In fact, studies show running is associated with a host of life-prolonging factors, including improved cardiovascular health, enhanced immune system, better weight management, and reduced risk of chronic diseases.

Dykes followed a training plan that was as unconventional as he is. It's based around what he calls the four F's: faster, farther, frequently, and fun. He'd pick a period of time—a month, a year—and try to either put in more mileage, increase

**'SAVE YOUR MONEY
AND YOUR LEGS
FOR RETIREMENT.'**





Dykes traverses the unforgiving terrain of Arizona's Vermilion Cliffs National Monument. He never wears headphones, because he doesn't like the distraction. Running gets his full attention.



his pace, or run more often. "And, of course," he says, "always have fun." Meanwhile, he avoided stretching, strength training, and special diets. Like weight lifter Nora Langdon, Dykes never wore headphones, preferring to enjoy his

surroundings instead.

But in 2022, something changed in Dykes's body. While running, he began to feel weirdly fatigued. He thought: Oh boy, is this what it's like to get old? During a 5K, he found that he could barely run. He decided to see a doctor—and good thing he did. The doctor took tests and diagnosed Dykes with blood cancer. Treatment began immediately, and, fortunately, he went into remission. Dykes being Dykes, he was back racing two weeks after the good news. Now he takes daily medication and is hopeful he can manage the incurable but treatable cancer the rest of his life. He credits racing. "I would never have found out about it if I weren't a runner," he says. "Maybe eventually, maybe when I dropped over dead."

The diagnosis hasn't stopped him from running, but it has changed his approach. After years of logging high mileage, believing that, as he says, you've got to have your mind overrule your body sometimes, he is now listening to his body and trying a reset. The 77-year-old ran the Boston Marathon in April and then began an extended break in which he plans to rest, try new recovery techniques, and, he hopes, prepare for the next potential goal: all those 80-plus age-group records that await.

CALM YOUR MIND, PUSH YOUR LIMITS

For most of her athletic life, Rebecca Rusch felt invincible, the rare athlete able to switch sports effortlessly and, seemingly, push past most natural limits. Then, in midlife, a freak accident coupled with the stressors of menopause forced her to make hard choices—and led to a new appreciation for her mental health.

Born in Puerto Rico, Rusch lost her father—a U.S. Air Force F-4 pilot—at age three when he was shot down during the Vietnam War, a loss that would come to shape much of her life. After running competitively in high school, she discovered climbing, notching the first female ascent of El Capitan's Bermuda Dunes trail in 1996, and went on to become an early champion in the emerging sport of adventure racing—a grueling blend of trekking, mountain biking, paddling, and

navigation that demands both endurance and resilience over days-long wilderness challenges.

At 38, she pivoted to solo mountain biking and came to dominate the sport. She won the Leadville Trail 100 MTB, a high-altitude course in the Rocky Mountains, then won it three more times. Twice she finished first among women in a 350-mile bike race on the Iditarod Trail over ice and snow in the Alaska wilderness. And she became the only person to bike the

length of the Ho Chi Minh Trail through Vietnam, Laos, and Cambodia, a feat spurred by her quest—ultimately successful—to find her father's crash site. She's now won seven world championships and is enshrined in the Mountain Biking Hall of Fame.

Even so, as Rusch approached and then surpassed 40, her body—the one that never failed her—began to change in real time. She needed sleep more than ever but had a harder time getting it (our





→ **REBECCA RUSCH, 57**

In Idaho, the lifelong adventure racer, seen below with husband Greg Martin, pivoted to mountain biking in her late 30s as her body started needing more recovery. She now holds seven world championships.



sleep quality and duration decline the older we get). Recovery took longer. On top of all that, she began navigating menopause: hot flashes, joint pain, staccato sleep patterns. Then, in 2021, she crashed and hit her head on a rock during a trail ride, suffering a traumatic brain injury that left her with a host of symptoms—depression, anxiety, headaches.

For Rusch, her crucial change came in the period after the accident, when she began concentrating on the mental aspect of training and recovery as well. She entered therapy, and, after years as a self-proclaimed naysayer of meditation, she began regularly practicing, swayed after she looked into the research. Functional MRI studies have found meditation leads to changes in brain structure and function, including increased gray matter density, which is associated with improved memory and emotional regulation, and altered brain activity patterns, which can enhance focus and resilience under stress. Meditating can be particularly helpful for athletic performance; a 2024 metastudy in *Frontiers in Psychology* found mindfulness training reduces an athlete's anxiety, improves performance, and boosts what's known as fluency—the optimal competitive psychological state,

where the athlete's attention is entirely centered on the task. "It doesn't really cost anything to meditate," Rusch says. "And especially for a hard-charging athlete, it's really interesting. It's cool to practice sitting still for 10 minutes."

Rusch began to realize the value of that processing time. Long training rides, which she embarks on without headphones, became "moving meditation." Along the way, she shifted her mindset, focusing on finding the joy in sport. Instead of tying her identity and self-worth to her performance, she reminded herself that she does this because "it is fun, and it feels good, and I feel better when I am doing it." She also looked to reframe the pain, darkness, and trauma of her concussion recovery, which stretched on for years, as an emotional growth opportunity. Mindfulness helped. So did self-reflection.

Rusch became a frequent journaler, logging her workouts, reactions, and thoughts in a small notebook. It's a practice now embraced by many top athletes, including Katie Ledecky, Michael Phelps, and Simone Biles, and studies show it helps with problem-solving, emotional regulation, and competitive stress, and enhances athletic performance. In Rusch's case, she says the



**'IT'S COOL TO
PRACTICE SITTING STILL
FOR 10 MINUTES.'**



In 2021, Rusch experienced a traumatic brain injury that motivated her to take better care of her mental health. Today she regularly meditates and journals, both of which are known to aid athletic performance.



key step is going back and rereading her entries. She compares it to being your own coach or therapist. “It’s actually a pretty interesting way to see what’s surfacing up for you,” Rusch says. “That’s what a good coach would do. That’s what a good therapist would do is just ask the right questions.” She continues: “As I get older, I’m starting to learn that I can ask myself the right questions and be like, What was great about that experience? And just kind of reflect on it a little bit. Or, Why was I in such a bad mood after my run today? Oh, well, I wasn’t really focused. I was distracted by work.”

Today, at 57, Rusch, who lives near the Sawtooth Mountains, in Idaho, values quality over quantity. She often takes off two days a week, and when she works out, she does interval training. But it’s the internal habits—the moments of pause, the willingness to reflect—that now guide her performance. “Who cares how fast you run a 10K?” she says. “The most important part of being an athlete is to feel good and to be able to get up and off the floor and to hang out with your friends and pick up your grandkids.”

These days, mindfulness isn’t something she squeezes in between training sessions. *It is the training.*



→ GER KENNEDY, 54

Irishman and former rugby player, Kennedy took up swimming in cold temperatures after an arthritis diagnosis at age 40. He has completed 19 official Ice Miles, which are full-mile swims in water that's 41°F or lower.

WHY IT'S NEVER TOO LATE FOR A NEW FAVORITE SPORT

What do you do when your body no longer allows you to participate in the sports you love?

Growing up on the north side of Dublin, Ger Kennedy played Gaelic football and rugby. By his 30s, he had a family and a full-time job as a plumber—honest work, but not easy on the body. As sports injuries mounted, he traded the crash-and-dash of rugby for running and

cycling, entering his first Ironman at the age of 39.

Still, all that pounding on his joints built up. He began experiencing swelling in his knees and hips. “I wasn’t able to run anymore, because the consequences would be two or three days in bed,” he says. “Cycling was good, but the hills were killing me.”

When Kennedy was 40, his doctor diagnosed arthritis in his right hip and knee. Surgeries followed, but Kennedy couldn’t avoid the inevitable; a hip replacement awaited, scheduled a

year and a half out, in 2012. During this time, his mental health took a hit. He turned to antidepressants, alongside anti-inflammatories. “I had no way of exercising correctly,” he says. “I’d lost my outlet.”

For anyone, this can be a dark time. Not only do you lose the myriad physical benefits of exercise, from the endorphin rush to improved sleep, but the psychological hit is profound. A 2023 analysis in the *International Journal of Environmental Research and Public Health* found a direct link between injuries and depression in athletes. Kennedy needed to do something.

With his lower body out of commission until surgery, only one sport remained for Kennedy: swimming. Thanks to the buoyancy of water, the stress on joints is significantly reduced. “Even though we do tell people that walking and running can actually help with arthritis,” says researcher Hirofumi Tanaka, referencing studies that show weight-bearing exercise in moderation can strengthen bones, “the pain is often too much. Water allows you to exercise fairly strenuously without that discomfort.” Indeed, decades of research have shown that swimming is one of the most effective and sustainable forms of exercise for older adults, offering



cardiovascular, muscular, and joint health benefits with minimal injury risk.

A friend recommended to Kennedy that he go to the Forty Foot, a historic swimming spot south of Dublin, from which people have launched into the frigid

sea since the days of author James Joyce. Kennedy's first reaction, as he recalls: "You're off your rocker. No way." Still, one gray morning he tried it in a wet suit. He eased into the waves and—*boom!*—the cold walloped him. "My hands, my face,"

he says. "I was like, Oh my God, this is crazy."

Then he got out and he felt better. "I got a lot of relief out of [it], mentally and physically," he says. Part of that was the exercise. But Kennedy's choice of where and how to do it also mattered. Immersion in cold water produces a host of physical reactions, including a huge spike in dopamine. Rigorous studies are lacking, but a number of preliminary and anecdotal studies show that it might also help with mental health and depression. A 2023 study in *Biology* found that after cold-water exposure, participants felt more "active, alert, attentive, proud, and inspired and less distressed and nervous."

In Kennedy's case, he kept coming back, swimming out to a set of buoys at 7 a.m. Soon enough, he shed the wet suit. Onlookers told him he must be mad. But he upped his mileage, adding in pool swimming. He joined an informal group of like-minded cold-water acolytes. The sport gave him an outlet, a community, and a purpose again. The blast of feel-good chemicals—and other potential benefits, like immune system strengthening—was a bonus.

Around 2012, Kennedy heard about a new extreme sport: ice swimming. It's just what it sounds like: swimming in water at 41 degrees

Fahrenheit or lower in just a latex cap, a regular swimsuit, and goggles. No neoprene, no gloves, no warm hat. Kennedy had always enjoyed pushing limits. He gave it a go.

Immediately, he took to it. In 2013, at a ribbon lake in Ireland, he attempted an Ice Mile, one of the most daunting—and dangerous—feats in extreme sports, a test of mental and physical endurance that requires covering a mile in ice swimming conditions. Most who try don't make it. Kennedy not only pulled it off—becoming the 55th person in the world to do so—but that was only the beginning. He took on marathon swims, entered ice swimming championships, and, in 2019, became the first man to complete the “Ice Sevens” challenge, swimming an Ice Mile on all seven continents and in a polar body of water.

Nothing about these swims was easy, which is part of the appeal. Similar to an ultramarathon, ice swimming forces you out of your comfort zone. The urge to quit, to just get out of the water, is overwhelming. Hypothermia looms. But if you stay in, the sense of accomplishment and self-confidence is galvanizing.

Interestingly, Kennedy credits his age—or at least his experience—as an



Kennedy's love for cold water began at Dublin's historic Forty Foot swimming hole (above, with Kennedy standing in front). At right, he takes an ice bath. Opposite page, Kennedy enjoys spending time with fellow swimmers like Gar Roche (top center and bottom left) and John Charles Curley.





'I THINK YOUR OWN LIFE JOURNEY AND WORK ADDS TO YOUR ENDURANCE!'

important factor in his success. "I think your own life journey and work adds to your endurance," he says. Kennedy ticks off stressors he's faced: his body crumbling, his divorce, parenting, his job as a plumber. "I think all these challenges make you pretty bloody strong."

Kennedy refers to this as the "endurance brain," a term he sees as a key to success for aging competitors. "I think that's why a lot of older athletes—even in American swimming, not just ice swimming, modern swimming—are achieving into their 60s, because they've

got all this knowledge and skills between motherhood and fatherhood, between screwups and life."

Now 54, Kennedy has completed 19 official Ice Miles and competed in swimming events around the world. He is the chairperson of the Ireland arm of the International Ice Swimming Association. He doesn't take any of it too seriously—and this may be just as important as anything else. "We do hard-core stuff, but we also have great fun and we enjoy the company," says Kennedy, who was headed out to an Anthrax show with his mates after a recent interview. "We have a few beers and we laugh at each other."

He's determined to swim as long as his body will allow, and still relishes the moments when he can surprise people, like when he recently completed a swim at 78° north latitude, in the Arctic. "No one expected it," he says with a grin. "They were like, 'Holy s--t.' And I said, 'Yep, the old man's still got it.'" Looking ahead, Kennedy is planning for another Ice Mile.

It's a theme that runs through the lives of all these athletes and countless others: You don't stop taking on challenges because you grow old. You grow old when you stop taking on challenges.

WORDS BY
CHRIS COHEN

A GAME PLAN FOR FIGHTING FATHER TIME

Five research-backed, peer-reviewed ways to start extending your health span now—no matter how old you are.

CARE
FOR YOUR
BRAIN BY
BEING
SOCIAL

• Most people understand that making an investment in your physical health, like quitting smoking or getting in shape, could lead to a longer, healthier life. It turns out that the same can be said for

investing in your personal relationships. Spending time with friends and family—or signing up for a recreational sports league team—could pay dividends down the road.

Maintaining social ties seems

BROADEN YOUR DEFINITION OF EXERCISE

to work like mental exercise, by promoting new connections in your brain and slowing down age-related cognitive decline. And you don't need to be a social butterfly to reap the benefits of connecting with other people.

A recent study found that having even one social interaction a month can cut the incidence of developing dementia in half. And the benefits are even greater if you connect with a person that you can confide in.

"It is very important to be socially active for our brains," says Suraj Samtani, a lead author of the study and a dementia researcher at the

University of New South Wales, in Sydney, "but we don't need that much" to make a big difference. Since conducting this research, Samtani has ramped up his own social life through exercise. "I started karate, and I catch up with friends and go for walks every week," he says. "It has just changed the way I do things."

It's almost impossible to overstate how good physical activity is for your health, no matter how old you are. But you don't necessarily need to be deadlifting 400 pounds or running an ultramarathon. Just a little bit of movement—taking the stairs, carrying groceries—has significant health advantages for otherwise inactive people. "Any little good that you can do is great," says I-Min Lee, professor of medicine and epidemiology at Harvard University.

We are only now verifying these insights, Lee says, because of a new generation of long-term studies that equipped participants with accelerometers (think fitness trackers). And she found that, contrary to popular thinking, the longevity benefits of walking hit much sooner than 10,000 steps. Other studies have linked shorter walks to improved mental and cardiovascular health.

Similar benefits come from short bursts of more vigorous activity, such as walking up a hill. "Really tiny amounts—anything from two to four minutes per day," says Emmanuel Stamatakis, professor of physical activity and population health at Australia's University of Sydney. In one study, he discovered that these bursts of activity are associated with a substantial reduction in the incidence of various types of cancer.

In other research using comparable data, Lennert Veerman, a professor of public health at Griffith University in Gold Coast, Australia, found that for the least active portion of the population, each hour of walking translates to six extra hours of life. "That's quite a good return on investment," he says.

BUILD UP YOUR CARDIO CAPACITY

No matter what new longevity science comes out, many researchers still consider cardiovascular fitness level as one of the best measures of overall health. Luckily, it can be improved with consistent

exercise—and easily tracked.

The gold standard for evaluating your performance level is to calculate the maximum rate of oxygen you use during exhausting physical activity, which occurs at the period during your exercise when you're breathing hardest. This figure is called VO2 max, and a precise

measurement of it usually requires breathing into a mask connected to a tube in a lab. But consumer-wearable devices like GPS running watches provide a general estimate.

Whether your number is in a good or a bad range depends on your age and gender. For example, a VO2 max of 40 milliliters of oxygen per kilogram per minute would be considered below average for a 25-year-old man but excellent for a 75-year-old. Either way, that number strongly correlates to your heart health and overall lifespan. "Individuals who have a higher VO2 max have a lower

risk of dying from all causes," says Martin Gibala, a professor of kinesiology at McMaster University in Hamilton, Canada.

Over time, moderate to vigorous cardio workouts of all kinds can boost your VO2 max, training your body to more efficiently process oxygen and turn it into energy. A quick workout to do just that is a high-intensity exercise: for example, a 20-minute workout that includes three vigorous five-minute efforts. The specific movement matters less than the intensity. It could be cycling, running, or using an elliptical or rowing machine.

DON'T LET YOUR MUSCLES GO TO WASTE

Raw strength is strongly associated with a healthier life. If you train for stronger muscles and bone density now, you'll have a greater chance of remaining independent as you

age. The American College of Sports Medicine recommends everyone perform some sort of resistance training at least twice a week. But what's the best strategy to actually make those

CULTIVATE GOOD EATING AND SLEEPING HABITS

You'll only get the gains you deserve from your workouts if they're paired with solid recovery and nutrition. And while the wellness industry would like to sell you gadgets and supplements for that, it's best to start with some basics.

For recovery—from the gym and from life—nothing is more important than sleep. And a foundation for better rest is, simply, routine. Studies indicate that people who go to sleep and wake up on a regular rhythm get more and higher-quality sleep.

This is because your body is hard-wired to operate on a roughly 24-hour circadian cycle. Disruptions can lead to “increased risk for cardiovascular disease, increased risk for cancer, changes

strength gains?

A helpful answer is emerging from science—and is already common knowledge at your local gym. Lift weights that are heavy for you, and try to progressively add weight over time. How heavy is heavy? An important concept is “muscular failure,” the point at which you can't perform even one more repetition. “You need

to know where failure is to know how hard you're supposed to be training,” explains Brad Schoenfeld, a leading strength-training researcher at Lehman College in the Bronx, New York.

While you can make appreciable gains in other ways, studies show the optimal strength workouts consist of low numbers of reps (one to six)

in mental health, all those sorts of things,” says Tara LeGates, a professor at the University of Maryland School of Medicine.

And while the prevailing diet advice often focuses on what you can't eat, a better approach is to find a way to feel full and satisfied from whole, unprocessed foods. Fill your plate with vegetables, grains, and meat, fish, or plant proteins—stuff you enjoy.

One landmark study provides some insight as to why: Researchers compared a diet of ultra-processed foods—factory-made, ready-to-eat items—and a diet of whole foods. While the two diets were nutritionally equivalent, study participants who went on both diets for two weeks each gained weight on the processed diet. Industrially prepared foods seem to mess with your sense of hunger. The study subjects said the taste of the two options was equally appealing, but they ate more of the ultra-processed foods all the same.

The good news is that your whole-foods diet can (should!) be delicious. “The more you can do to structure your life so that you're not having to constantly resist temptation, the better,” says Zachary Knight, a physiology professor at the University of California, San Francisco, who studies the internal processes that govern hunger. “That means having healthier foods at home.”

performed relatively close to failure—two or three reps away. In other words, strength workouts are ideally quite strenuous. But this training only needs to take an

hour or so each week. “You can make very nice gains with a fairly minimal routine in three or even two days a week,” Schoenfeld explains, “provided you train hard.”

AS TOLD TO
DEVIN GORDON

PHOTOGRAPHS BY
PAOLA KUDACKI

'I WANT TO LIVE TO BE 100'

These iconic athletes were the greatest of all time at what they did, so who better to ask about getting the most out of our bodies as we age? We came in search of wisdom, but they gave us something even better: motivation.



Nadia Comăneci was the first gymnast to achieve a perfect 10 at the Olympics. While she hasn't competed in over 40 years, she stays in shape by exercising every day. And when she misses the feeling of being a gymnast, she heads to the balance beam.



• NADIA COMĂNECI 63

Comănechi was just 14 years old when she scored the first ever perfect 10 by an Olympic gymnast, at the 1976 Summer Games in Montreal, and then she did it six more times in what many sports historians consider the greatest performance of the modern games. Her combination of athleticism and artistry captivated a global television audience. Five years after her retirement in 1984, she defected from Communist Romania to the United States and later married U.S. Olympic gymnast Bart Conner. They now run a gymnastics academy in Norman, Oklahoma.

“

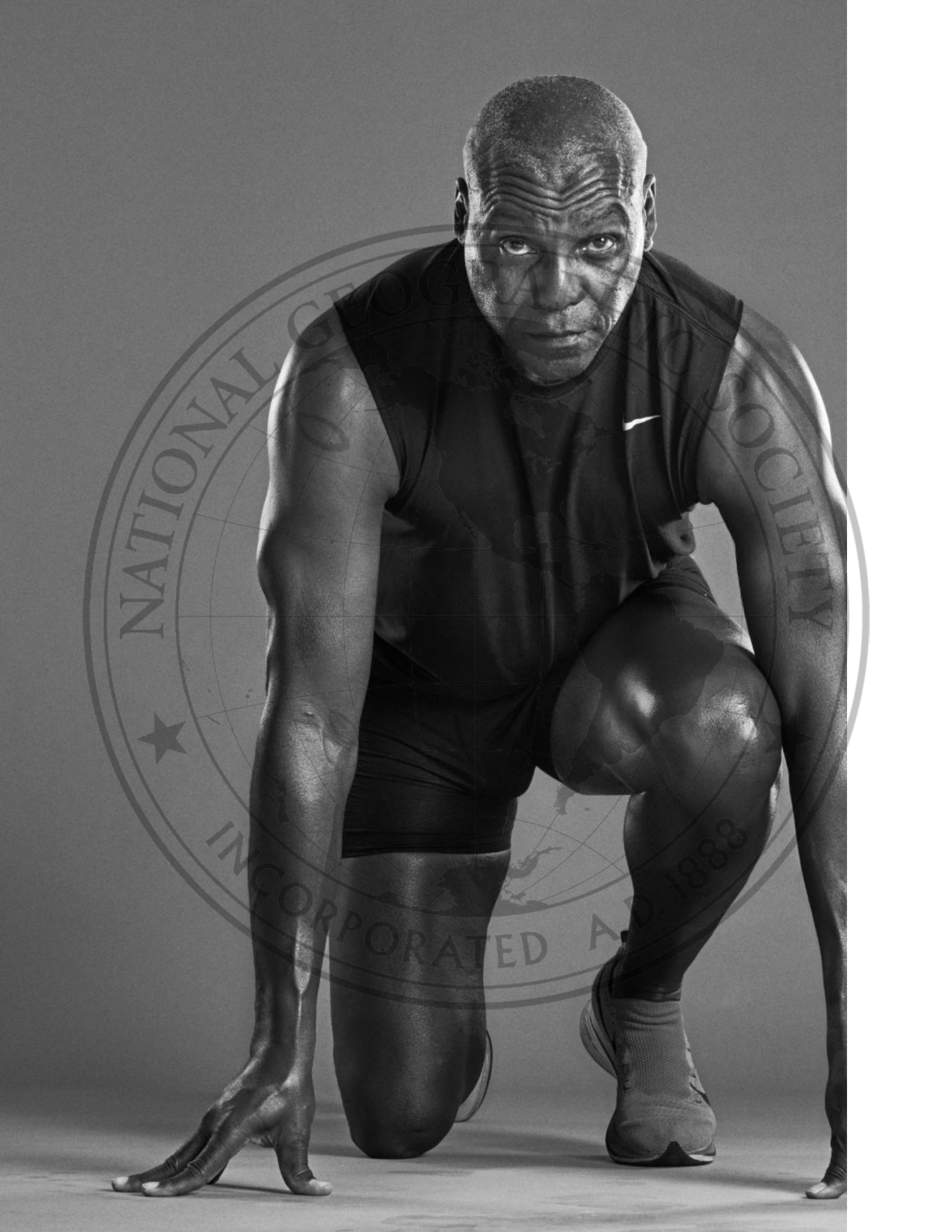
IN MY TIME, athletes used to compete and then they retired. I stopped exercising in the 1980s because there was not enough information yet on how keeping your body in good shape would help you navigate your long-term health better. I thought all that came from genetics! But I was playing soccer for fun with some of my friends, and I realized I was gasping to breathe, and I was like, Oh my gosh, that doesn't seem right. Especially for a former athlete.

My habits changed when I came to the United States and discovered Gold's Gym. We have a house in Venice Beach, California, and the original one was right across the street, where Arnold Schwarzenegger worked out—I saw him there a lot. It was an introduction to a different kind

of lifestyle, and then it becomes a part of your day-to-day life. I realized over time that my body was developing different muscles and that I felt better. That was the most important thing. I was even thinking better.

Now I work out 40 minutes a day, no matter where I am. And I'm very realistic. Your body tells you what you can do. I don't run, for example, because I feel my joints will go out too fast. People often say to me, 'Nadia you're in good shape!' And I say, 'Yeah, like a *human* shape.' I'm in OK shape, but don't expect me to do a double twist. If I miss that feeling, I go and get it by walking on a beam, doing some turns; getting out on the floor, doing some artistic moves. I stopped competing many years ago, but I didn't get away from the sport. It's always there for me.

- GYMNAST
- 7X 'PERFECT 10' AT OLYMPIC GAMES
- 5X OLYMPIC GOLD MEDALIST
 - ALL AROUND
 - UNEVEN BARS
 - 2X BALANCE BEAM
 - FLOOR
- 2X WORLD CHAMPION



• CARL LEWIS

64

In an era when top American sprinters were major celebrities, Lewis was a towering figure not just in the world of track and field but across sports: the fastest man alive throughout the 1980s and early '90s. At age 30, he broke the world 100-meter record, finishing in 9.86 seconds. He likes to say, when athletes started going to Las Vegas in the '80s, he hired a chef to improve his diet. Today he's head coach of the track-and-field program at his alma mater, the University of Houston.

- ▶ SPRINTER AND LONG JUMPER
- ▶ 9X OLYMPIC GOLD MEDALIST
- ▶ 8X WORLD OUTDOOR CHAMPION

- ▶ WINNER OF FOUR GOLDS IN THE 1984 SUMMER OLYMPICS:
 - 100-METER DASH
 - 200-METER DASH
 - 4×100-METER RELAY
 - LONG JUMP



“ IT FEELS LIKE everything changed when I turned 60.

Forty was nothing. Fifty was nothing. Sixty—it’s a lot harder now. It’s just a lot of little things. It feels like if I look at a calorie now, I gain weight. And I can’t sleep through the night anymore. That’s one thing that’s kind of frustrating. And of course I wake up twice a week wondering, “Why does my back hurt?” Or, “Why is my hamstring tight?” In the history of time, we’ve only been getting old for like three seconds. We haven’t lived this long for very long, so we’re finding out so much about aging ourselves.

I get fulfillment now from doing something every year that I never thought I would

do. I decided I wanted to bench 300 pounds at age 60, which is crazy. I got to 285. Then one year, I went skydiving. For 63, I wanted to do a split. I started training about six months beforehand, and I still haven’t done the split. It may take me until 65, but I’m going to do that damn split. And when I’m 65, I want to ride 65 miles on my bicycle in one day. The most I’ve gone is like 40.

I’ve always felt like you need to have two or three reasons why you want to push yourself. For me, I just feel better—physically and emotionally—when I work out and keep my weight down. And there’s definitely some vanity in there. I mean, come on, let’s be real! I ran around with more or less no clothes on. But also: I want to live to be 100.

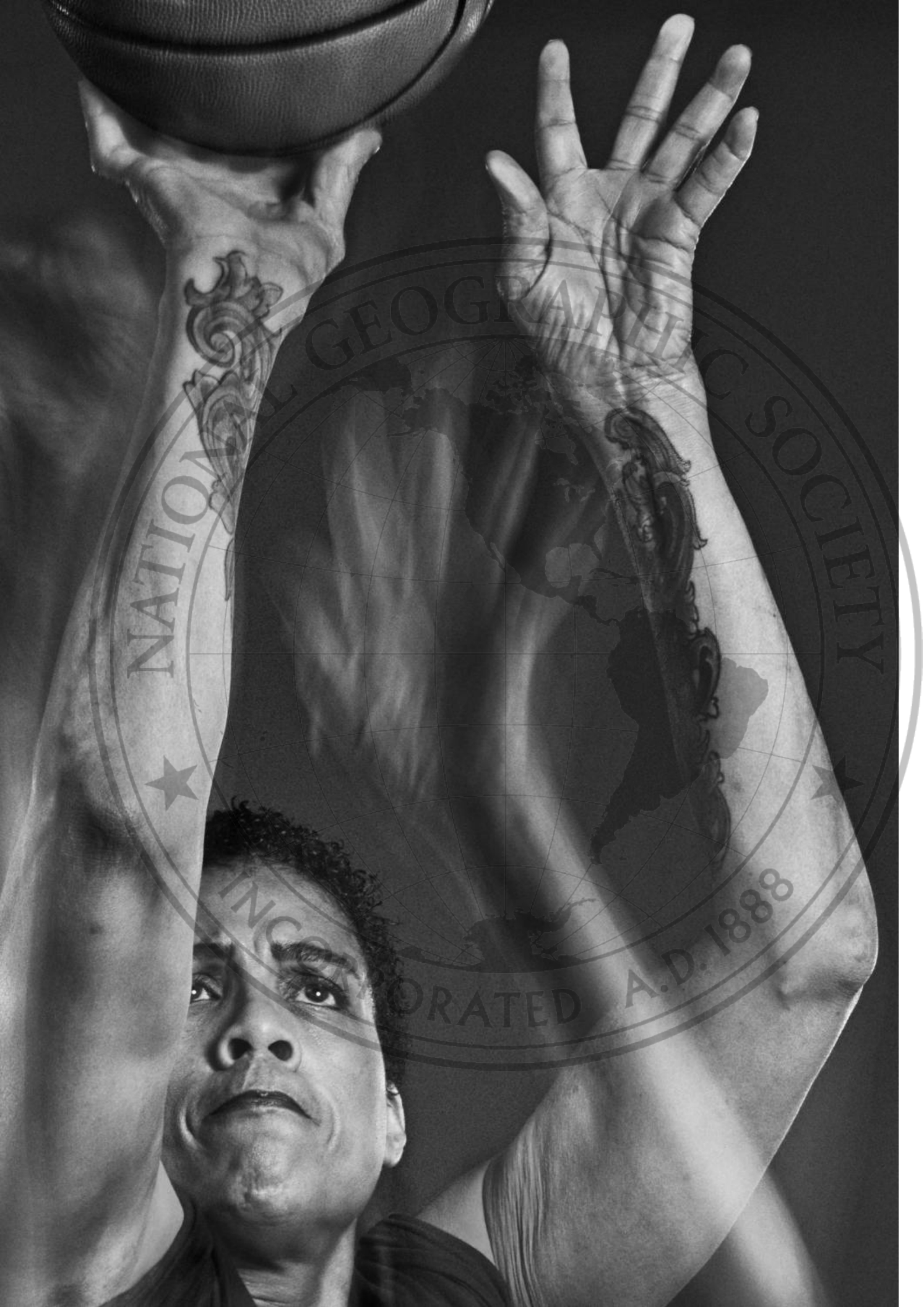
I try not to fall into the trap of saying, Oh, you were a super athlete, so you’re a superhuman. I’m a normal human.

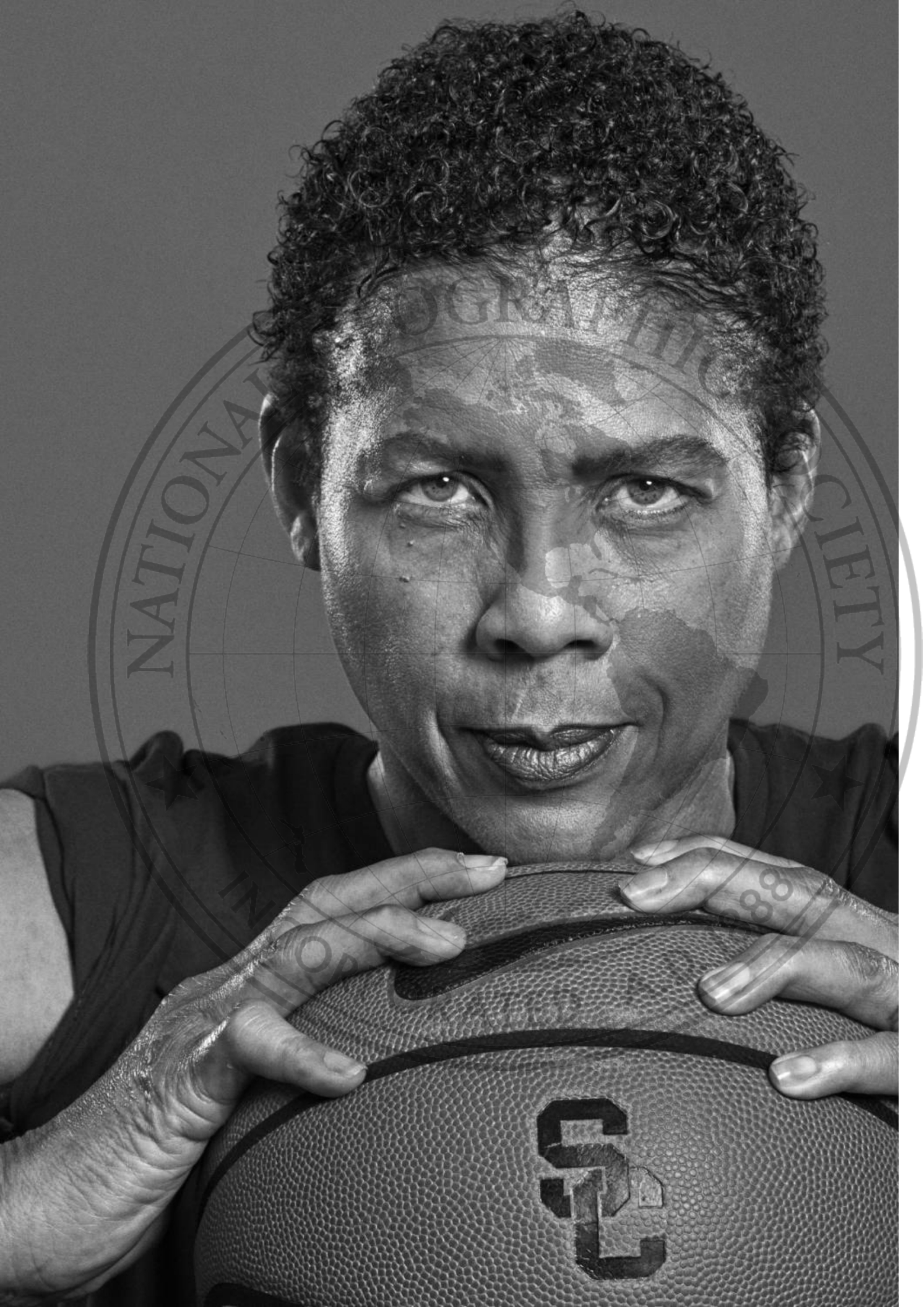
‘IN THE HISTORY OF TIME, WE’VE ONLY BEEN GETTING OLD FOR LIKE THREE SECONDS.’

• CHERYL MILLER 61

Women's basketball history goes back further than Miller, but she was the sport's first crossover superstar: leading the University of Southern California to two NCAA titles in the mid-1980s and being the centerpiece of the gold-medal-winning Team USA at the 1984 Summer Olympics in Los Angeles. The WNBA didn't come until well after her retirement, but she was one of the league's inaugural head coaches with the Phoenix Mercury.

- ▶ BASKETBALL PLAYER
- ▶ 1984 OLYMPIC GOLD MEDALIST
- ▶ BASKETBALL HALL OF FAME
- ▶ 4X COLLEGE ALL-AMERICAN
- ▶ 3X COLLEGE PLAYER OF THE YEAR
- ▶ 2X NCAA CHAMPION
- ▶ 3,018 TOTAL CAREER POINTS
- ▶ 1,534 REBOUNDS





“

THE LAST TIME

I played in a pickup game, I was 27, maybe 28. But since then, I haven't picked up a basketball competitively. The pain was already too bad back then. The crunching and the popping and the swelling—it wasn't worth it. I had bone spurs in the front and in the back of my knee. I could only walk for 20 minutes and then I'd immediately have to get home and do the icing, the elevation, but there was no relief. I was miserable. But the only reason why I finally got knee replacements—one around Thanksgiving of '23, the other in April of '24—is I couldn't ride a bike anymore. Why'd I wait so long?

**'NOW I HAVE
A SECOND
LEASE ON LIFE.
I'M A KID
IN THE CANDY
STORE.'**

Because of that old warrior mentality. Because I was a big dummy.

Now I have a second lease on life. I'm a kid in the candy store. I'm learning how to run again. I can at least get out there and put some shots up and move around. I wake up at four in the morning, get myself organized for the day, do my Bible study, and then I'm out the door and walking up hills and jogging, and it's such a joy.

I'll see a pickup game and I want to possibly get into it, but I'm not quite there yet. That curiosity is there, though. It's like, *I wonder if I can still get up and down the floor, get hit a little bit, set a screen, try to box somebody out, grab a rebound, make that outlet pass, sprint down, finish the layup.* Those are still things in the back of my mind. *I wonder...* With a smile on my heart, *I wonder.*

JERRY RICE

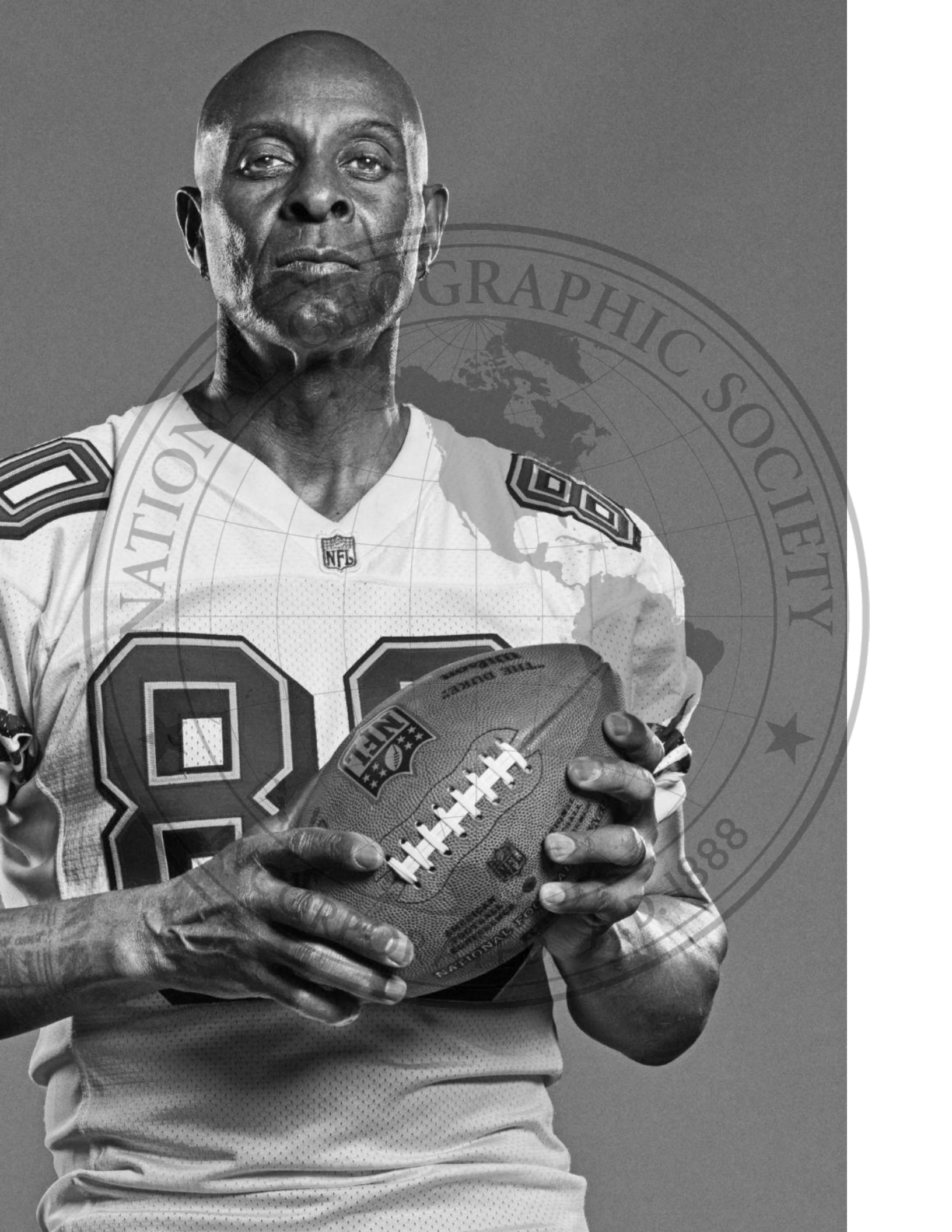
62

Rice is the NFL's all-time leader in catches, receiving yards, and touchdowns. And yet, coming out of little-known Mississippi Valley State University, Rice faced concerns he might be too slow and too untested. He wound up playing 20 seasons as a wide receiver while earning a reputation for out-working everyone on the field and always staying in flawless shape. He won three Super Bowls with the San Francisco 49ers. He still lives in the Bay Area and co-founded an energy drink business, G.O.A.T. Fuel, with his daughter and son-in-law.

- ▶ FOOTBALL PLAYER
- ▶ 3X SUPER BOWL WINNER
- ▶ PRO FOOTBALL HALL OF FAMER

- ▶ 22,895 RECEIVING YARDS
- ▶ 1,549 CATCHES
- ▶ 208 TOTAL TOUCHDOWNS





“ I WASN'T THE greatest athlete out there.

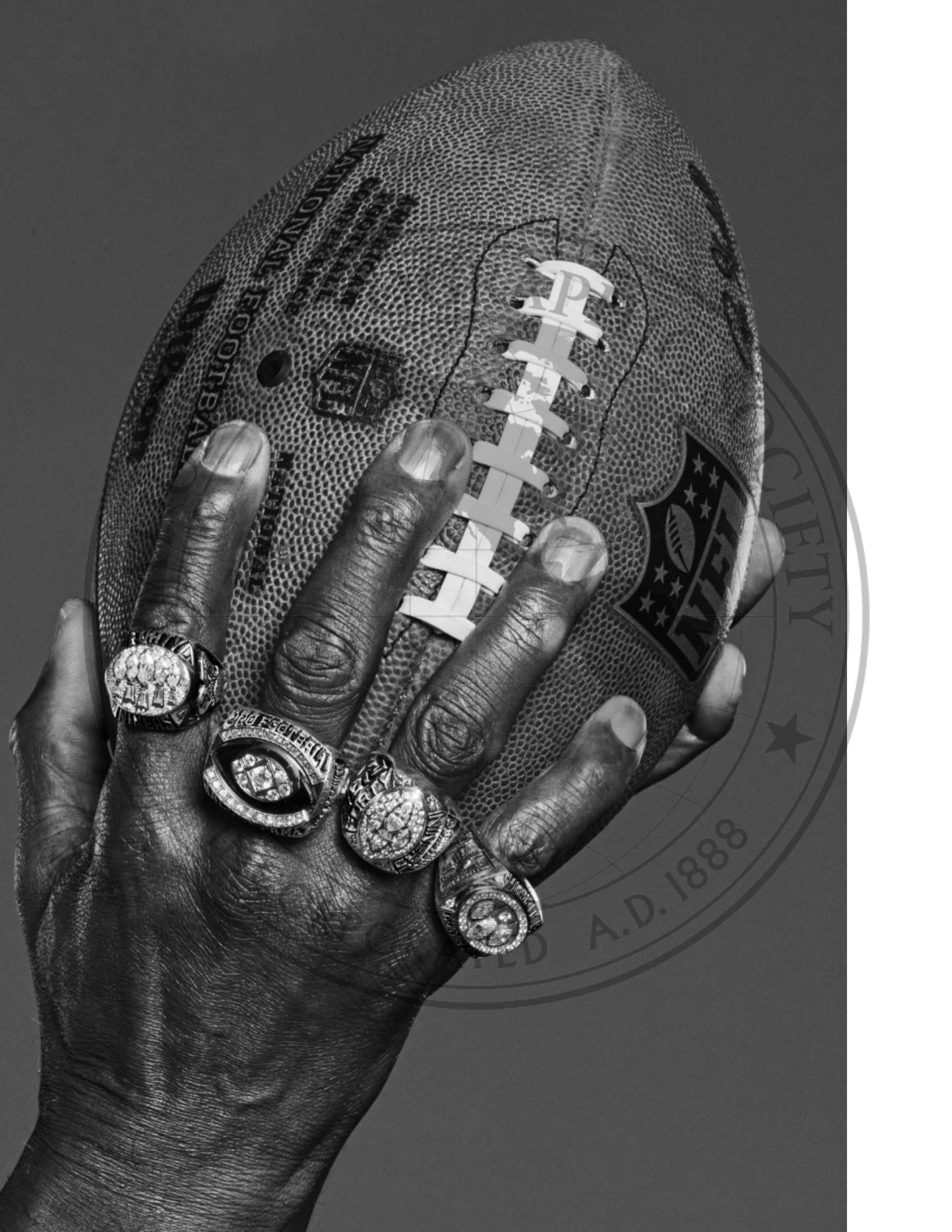
I wasn't the fastest. There were guys so much more gifted than I was—Cris Carter, Michael Irvin, Randy Moss. What they could do on the football field was amazing. I'm not saying those guys didn't work hard, but I knew I had to work harder. I was always reaching when I played, and I'm still reaching after retiring from the game. I'm not dialing anything back now, man. I'm always challenging myself to be the best individual that I can be. It's just in my DNA.

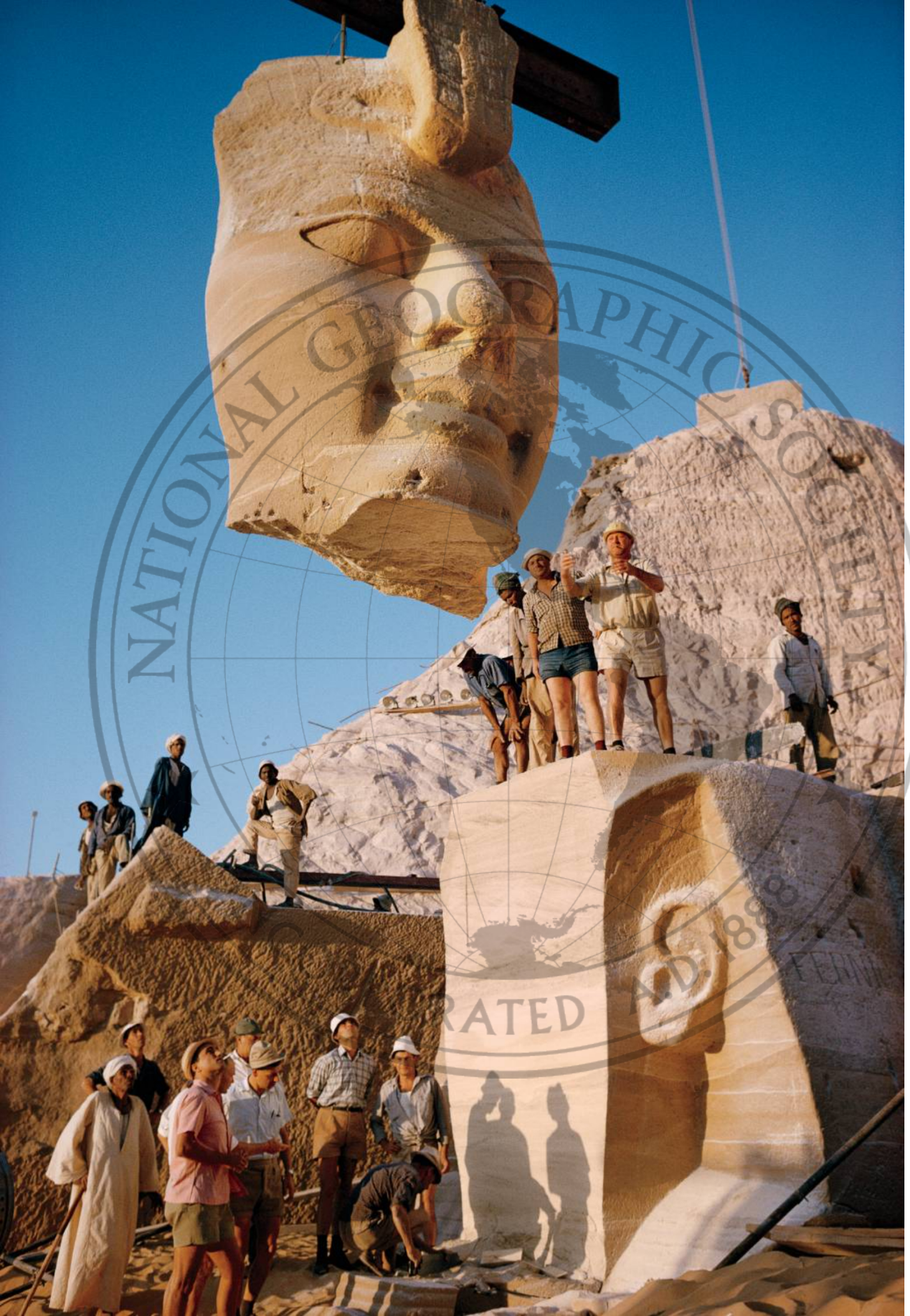
I want people to know that after you step away from something that you've been doing for a long, long time, life is not over. I actually believe that when people have nothing to do after their careers, that's when everything goes downhill. There's nothing to wake up for and be excited about. I wake up every morning and, well, I'm not going to say I'm excited to work out, because I know it's going to hurt—but it's going to put me in a frame of mind that, hey, I really did something

productive for my body and now I'm ready to be the greatest person that I can be during the day. I'm actually down to my playing weight now, and I've been out of the game for a long time.

I do a lot of Peloton, a lot of CrossFit. I also have a big South African mastiff, and he likes to run, so we get out there. And yeah, the knee is going to swell sometimes, and you might be a little stiff when you get out of bed. But you've got to fight through that pain, knowing that the ultimate goal is that you're still going to be flexible and active as you get older. So that's my motivational speech: Challenge yourself every day, and it's going to reward you in the end. □

'I WAS ALWAYS REACHING WHEN I PLAYED, AND I'M STILL REACHING AFTER RETIRING FROM THE GAME.'





How an
AMERICAN ICON
Helped Save
EGYPT'S
ANCIENT
TEMPLES

Sixty-five years ago, the temples of Abu Simbel were destined to disappear beneath the murky waters of a new dam. Then Jackie Kennedy got involved.

Words by
KATE STOREY

→ **TO SECURE ITS FUTURE**, Egypt had made the hard decision to let go of its past. It was 1960, and construction had just begun on southern Egypt's Aswan High Dam, which would generate hydroelectric power, provide more arable land, and control the flood-prone Nile River. But for all the good a dam would do, it was also going to be disastrous for the area's archaeological wonders. The massive reservoir was expected to destroy dozens of priceless historic sites, including the majestic twin temples of Abu Simbel.

Built more than three millennia ago, the monument was commissioned by Ramses II and chiseled directly into a sandstone cliff on the western bank of the river. The imposing facade of the main temple was guarded by four towering Ramses II colossi, each 67 feet high, and the nearby smaller temple was dedicated to Queen Nefertari and Hathor, the goddess of love, music, and dance. The temples' inner sanctums were carved deep into the cliff and filled with statues of Egyptian gods and reliefs depicting victorious military battles. It was one of Egypt's finest pharaonic treasures, and it was about to be lost forever.

In October 1965, the 19-ton visage of Ramses II was carefully cut from the Egyptian riverbank mountain where it had stood for more than 3,000 years and hoisted onto a truck headed to a new site. If not for an ally halfway around the world, Abu Simbel's famous statues may have been lost to a vast lake created by the Aswan High Dam.

To save Abu Simbel, an international consortium of conservationists launched an unprecedented rescue mission before the dam's completion in 1970. The plan was to cut the entire complex out of the mountain by meticulously deconstructing each stately chin, cheek, and crown—more than a thousand pieces in total—and then transporting and reassembling them on higher ground. In order to succeed, it would require unheard-of orchestration between the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and thousands of archaeologists, architects, and Egyptologists from dozens of countries. But with a cost equivalent to \$400 million today, the entire undertaking seemed far too expensive to pull off—until an unlikely diplomat intervened with a bold vision to support a project that ultimately transformed UNESCO and reshaped how future leaders in her role would go on to effect change.



Dubbed “one of the most dramatic rescues in history” by *National Geographic* in May 1969, the mission to save Abu Simbel spanned dozens of countries and cost the equivalent of \$400 million today.

Half a world away, future First Lady Jacqueline Kennedy had been closely monitoring the fate of Abu Simbel. Ever since reading about Howard Carter’s 1922 discovery of King Tutankhamun’s tomb, she’d remained fascinated by the mummies and pyramids of ancient Egypt. Years later, when a friend gave her a copy of the *UNESCO Courier*, the official magazine published by UNESCO, which called on world leaders to save Abu Simbel before it was too late, she vowed to protect the memory of the once mighty empire she’d learned about as a little girl.

After John F. Kennedy became president in 1961, Jacqueline got to work convincing her husband why it would be advantageous for the United States to get involved. But rather than just talking behind closed doors, the new first lady decided to go through more official channels. She crafted a carefully composed memo likening the loss of Abu Simbel to “letting the Parthenon be flooded,” underscoring the research possibilities of the temples and how important they were to the whole of Africa, a region with which JFK was trying to strengthen diplomatic ties during the Cold War.

She gave the note to White House adviser Richard Goodwin, who then helped draw the president’s attention, and the financial might of the U.S., to Egypt. “I convinced the president to ask Congress to give money to save the tombs at Abu Simbel,” Jacqueline proudly recalled later. But there was a caveat. “He [only would] if I could convince [Republican Congressman] John Rooney of the Appropriations Committee, who was always against giving money to foreigners.” She was ultimately successful, and the U.S. government announced its intention to cover up to one-third of the cost. The rest would be financed by Egypt and UNESCO.

Of course, she wasn’t the first woman in the White House to use soft diplomacy as a conduit for influencing matters beyond

PHOTO: GEORG GERSTER, NATIONAL GEOGRAPHIC IMAGE COLLECTION

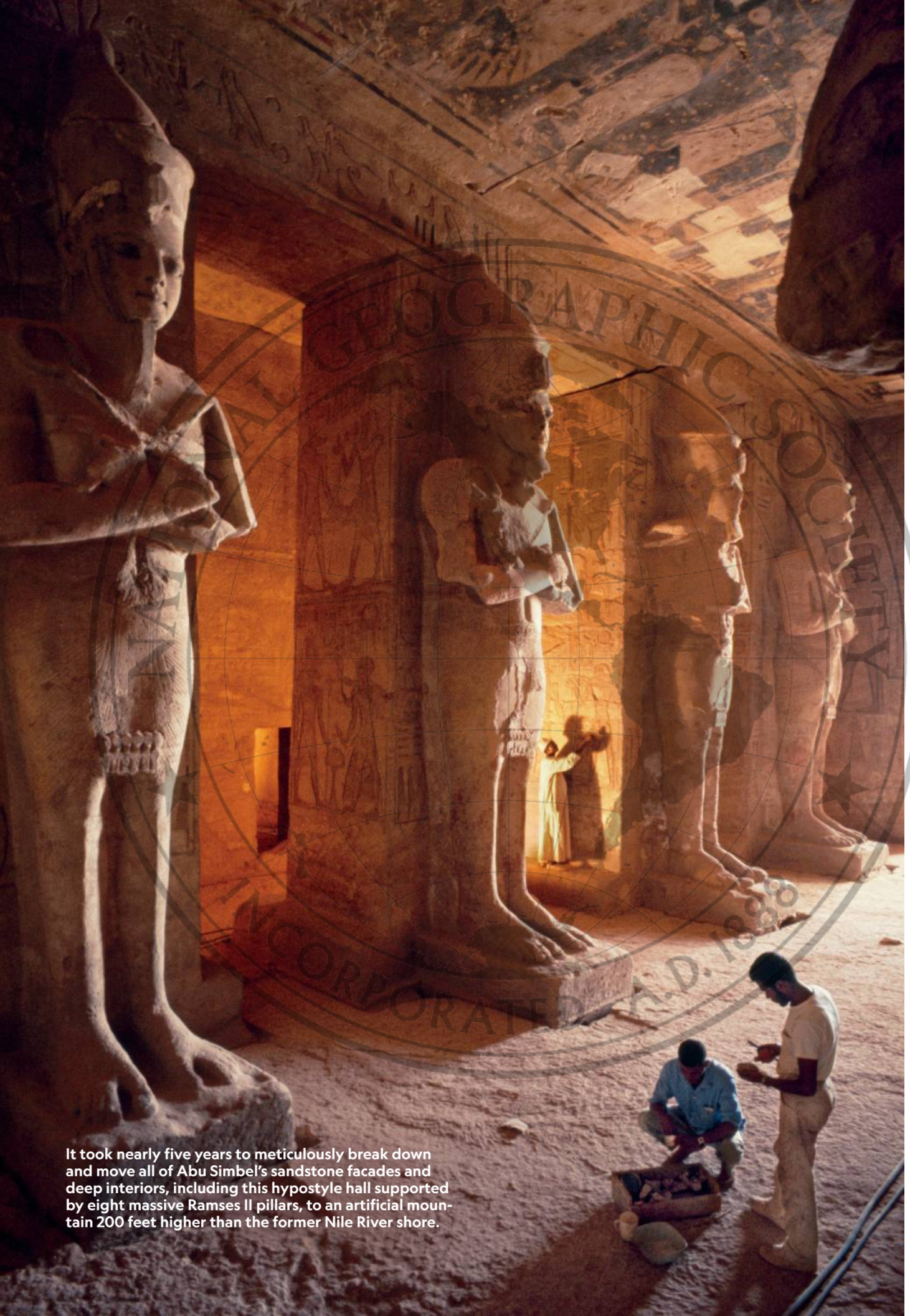


After persuading her husband, U.S. president John F. Kennedy, to help fund the costly Abu Simbel preservation project, Jacqueline Kennedy drummed up additional financial support in 1961 by inaugurating an exhibition at the National Gallery of Art in Washington, D.C., featuring 34 artifacts from King Tutankhamun's tomb.

traditional lines of negotiation. First Lady Eleanor Roosevelt, who famously visited troops in the South Pacific during World War II, was often referred to as the “eyes, ears, and legs” of President Franklin Delano Roosevelt. But prior to Jacqueline, a first lady’s diplomatic duties almost always took the form of trips abroad or hosting dignitaries at the White House. “A woman’s credibility was part of what created liking and friendliness and cooperation, and would soothe the relationship often between the heads of state,” says Elizabeth J. Natalie, author of *Jacqueline Kennedy and the Architecture of First Lady Diplomacy*. “[She] created the blueprint for the way

in which first ladies use different kinds of communication tools.” Pointing to initiatives like First Lady Michelle Obama’s Let Girls Learn, a plan to increase educational opportunities for young women worldwide, Natalie adds that now “first ladies can actually influence policy.”

A plan was put into place in 1963, and a team of Egyptian, German, French, Swiss, and Italian workers—among them master marble carvers from Carrara, Italy—then cut Abu Simbel into enormous blocks weighing up to 33 tons using a variety of tools, including handsaws. The blocks were numbered and taken via flatbed trailers to a new artificial sandstone mountain 200 feet



It took nearly five years to meticulously break down and move all of Abu Simbel's sandstone facades and deep interiors, including this hypostyle hall supported by eight massive Ramses II pillars, to an artificial mountain 200 feet higher than the former Nile River shore.

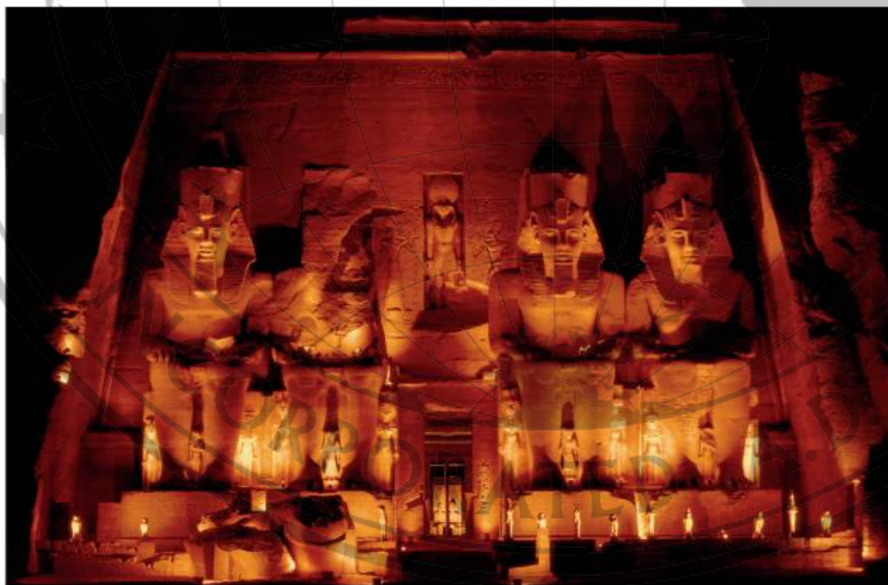
higher than the old Nile shoreline and 690 feet inland. Crane operators resurrected the grand pharaonic work piece by piece, like a giant Lego set successfully put back together again.

Thanks in part to Jacqueline Kennedy's powerful private lobbying, Ramses II and the rest of the Abu Simbel statues reign safely again in southern Egypt, ready to survive another 3,000 years. In honor of the support fostered by the first lady, Egypt offered the U.S. the smaller temple of Dendur, a first-century B.C. shrine also saved from the Aswan High Dam, which is now on display at the Metropolitan Museum of Art in New York City. Ultimately, JFK never got to see the end result of his wife's work. He was assassinated before the relocation of Abu Simbel even began.

Today Jacqueline's preservation efforts in the U.S.—from the White House to New York's Grand Central terminal—are widely lauded, but her contributions in Egypt have

been largely overlooked. However, her daughter, Caroline, once remarked that her mother “felt that of equal importance to her White House restoration were her far less well known efforts as first lady to save Abu Simbel.”

While there was little public recognition of the role she played, Jacqueline was instrumental in securing funding for a venture that helped set the stage for future conservation endeavors across the globe. The work done to save Abu Simbel was a catalyst for UNESCO's World Heritage initiative that now safeguards thousands of notable landmarks, from the ancient ruins of Cambodia's Angkor Wat to the water channels of Venice. “That campaign was very symbolic in many ways,” says May Shaer, UNESCO's chief of the Arab States Unit for World Heritage. “It established a common standard to identify and protect cultural and natural properties that are considered to be of significance for all humanity.” □



Each year, hundreds of thousands of visitors from around the world marvel at the temples, which are illuminated at night during a sound-and-light show.



THE WORLD'S TALL MOUNTAIN?

A new approach to how we measure mountains is reigniting some long-simmering debates—and perhaps creating a new pecking order for the planet's most impressive peaks.

WORDS BY GORDY MEGROZ

GRAPHICS BY SOREN WALLJASPER

The imposing Himalayan mountain Annapurna, in Nepal, rises 26,545 feet above sea level. That elevation makes it the world's 10th highest peak. But there are many ways to size up a mountain, and by one new measure, Annapurna claims a more impressive summit than Everest.

EVEREST

**IT MIGHT NOT
BE WHAT
YOU THINK.**



Mount Everest, known as Sagarmatha in Nepal and Chomolungma in Tibet, has inspired awe since before surveyors declared it the world's highest summit, in 1856. Other peaks, however, rise higher—and perhaps more dramatically—from their base.

A

AT 11:30 A.M. ON May 29, 1953, Edmund Hillary and Tenzing Norgay stepped onto the summit of Mount Everest. Affixed to Norgay's ice axe were four small flags—of Nepal, the United Nations, Great Britain, and India—and as the Sherpa mountaineer held the axe above his head under a clear blue sky, the flags flapped wildly in fierce winds. In the 30 years prior, at least 75 others had tried to reach that summit, more than a dozen dying in the attempt, and Hillary and Norgay's successful ascent is still considered one of history's most monumental feats.

The reason is obvious, right? Because in 1856, British surveyors declared Everest the planet's tallest peak: the roof of the world, Earth's most impressive mountain.

But what if it's none of those things? What if our understanding of a mountain's scale—what height itself means and how much it matters—is more arbitrary than we realize? For one, it might change travelers' sightseeing plans or point peak baggers in whole new directions. Then there's the matter of reallocating bragging rights.

How to measure mountains, it turns out, has been subject to challenges and alternative ways of thinking for about as long as humans have been climbing them. And the latest comes from a young mathematician with a whole new metric that can once again alter our way of looking at the roof of the world.



During the 19th-century Great Trigonometrical Survey of India, measuring mountains meant hauling hefty instruments. It took 12 people to move a great theodolite (top), which can assess angles at substantial distances.

In 2020, Chinese surveyors set instruments atop Everest. Chinese and Nepalese authorities later announced a new elevation: 29,031.69 feet above sea level, almost three feet higher than previously measured.

It's called "jut." Its inventor, Kai Xu, was a 19-year-old on a trip to California's Eastern Sierra when it dawned on him that the height a mountain rises above sea level isn't the most interesting thing about it. The Sierras wowed him with how abruptly they seemed to rise from the valley floor. And Xu, then a math and computer science major at Yale University, thought there must be a way to quantify that sort of grandeur. The trip inspired him to do two things: First he worked out an equation that, roughly speaking, takes the height of a summit above any given point and reduces that number based on the angle of view. Then he used Google Earth Engine to pinpoint the one spot for any given mountain where that value is greatest. He called that maximized value a mountain's "jut," and it took Google's platform less than a week to compute it for some 200,000 mountains.

Xu launched a website to share his new system, and jut has since earned fans and sparked debate over what it is that makes a mountain matter. Everest, at 29,032 feet above sea level, has a meager 7,293 feet of jut—Xu's system ranks it only the world's 46th most impressive peak. Meanwhile, Annapurna Fang, also in the Himalaya, tops out nearly 4,000 feet below Everest, but with 11,194 feet of jut, it's ostensibly Earth's most impressive mountain face.

Xu is only the latest in a long line of scientists and adventurers to challenge conventional wisdom about orometry, the science of mountain measurement. In the fourth century B.C., the Greek thinker Dicaearchus is said to have used a crude surveying instrument called a dioptra to measure the Hellenic peaks. The 11th-century Persian scholar Al-Biruni used trigonometry to measure mountains more accurately. That was still the method when European explorers started poking around the Andes hundreds of years later. At 20,561 feet above sea level, Ecuador's Chimborazo was thought to be Earth's highest mountain when German naturalist Alexander von Humboldt climbed it in 1802. Later, Sajama in Bolivia took the title. Then Aconcagua in Argentina.

It was also in 1802 that the British launched the 70-year Great Trigonometrical Survey of India, which revealed to surveyors that the Himalaya loomed larger than any other mountain range. Crews hacked through jungles toting massive angle-measuring instruments called theodolites—some weighing more than 1,000 pounds—and established a network of survey stations that stretched 1,600 miles. Their labors laid the groundwork for modern methods of measuring Earth's surface.

George Everest, who led the effort for 20 years, probably never saw the peak later named for him, but he did hire Radhanath Sikdar. The Indian mathematician is credited with calculating Mount Everest's height, putting it above Kangchenjunga, one of several Himalayan peaks briefly thought to be the world's highest.

Everest's claim has held. But as mountaineering grew more popular and competitive in the 20th century, debates flared up over what truly defines a mountain's greatness. Terris Moore, a well-known mountaineer, made a case in the 1960s that because of the planet's equatorial bulge, a mountain might better be measured from the center of the Earth than from sea level. Chimborazo, he noted, would take back the title, rising higher than Everest does above the Earth's mean radius.

Beginning in the 1980s, some took to privileging the concept of prominence, a measure of a peak's height relative to surrounding terrain. Alaska's Mount McKinley and Tanzania's Mount Kilimanjaro, rising dramatically above their surroundings, are among the most prominent peaks but don't crack the top 100 for elevation above sea level. Xu took inspiration for jut from another esoteric metric, known as omnidirectional relief and steepness. Devised in 2002 by a mathematician-and-climber duo, it's a complex formula for quantifying how visually imposing a peak is, mostly useful for those looking to bag impressive ascents.

Here's a look at how these measures and others reshuffle the deck of Earth's mightiest mountains. Think you know the roof of the world? You might be surprised. □

JUAN DIEGO MONTENEGRO, SOFA IMAGES/LIGHT ROCKET VIA GETTY IMAGES





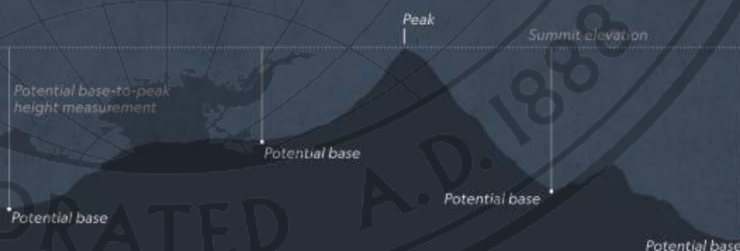
Ecuador's Chimborazo exemplifies the vagaries of mountain measurement. Its summit is thousands of feet closer to sea level than Everest's, but thanks to the planet's bulging middle, it's often called the mountain closest to the stars.

HAVE WE BEEN MEASURING MOUNTAINS ALL WRONG?

The process isn't as simple as it might seem. Sure, the summit of Everest is indisputably Earth's highest point above sea level. But what's so special about sea level? Measure a mountain in other ways—there are plenty to choose from, including the newly devised metric of jut—and you'll find a whole range of candidates for the title of loftiest peak. Turns out there's room at the top.

THE CRUX OF THE DISPUTE

We tend to agree where the summits are. But where to measure up from? Does sea level make sense when a peak is far from the coast? Measure from the base, some might say—except that most mountains are surrounded by complex terrain, with differing relief on all sides, and there is no agreed-upon method for determining a mountain's base. To gauge a mountain's stature, geographers and mountaineers might use one of several systems.



METHODS: Elevation above mean sea level Distance from the center of Earth Topographic prominence ORS Jut Other claims

Rakaposhi 1

Largest continuously sloping face
Other mountains rise higher than Pakistan's Rakaposhi, in the Karakoram Range, but over longer distances and more gradually. Its claim to largest base-to-peak rise owes to its sheer north face, which looms some 19,000 feet over the Hunza Valley.

RANK: 1st 3rd 9th

Mt. Everest 1

Highest above sea level
The summit of Everest occupies the so-called death zone, where oxygen is too scarce to sustain human life. But since the mountain rises from the already sky-high Tibetan Plateau, its height above its base may seem less impressive.

Mt. Everest
29,032 ft
8,949 m

Chimborazo's summit is about 7,000 feet farther from the center of Earth than the summit of Mt. Everest.

Chimborazo 1

Farthest from Earth's center
This dormant Ecuadorian volcano sits nearly on top of the planet's equatorial bulge, Earth's widest point. But while distant from the core, it doesn't even crack the top 30 in the Andes for elevation above sea level.

Cerro Aconcagua 1

Most prominent
With nothing higher for comparison, Everest wins prominence on a technicality. But really it's this peak in Argentina's Andes, isolated in its grandeur, since the closest higher peak is more than 10,000 miles away.

RANK: 1st 17th

25,000 ft —
Rakaposhi
25,581 ft
7,788 m

20,000 ft —
19,000 ft
continuously
sloping rise

10,000 ft —
5,000 ft —
Hunza
River Valley
(Base of
Rakaposhi)

Sea level

HOW THE GIANTS STACK UP

Each of these mountains—shown to scale with one another, with respect to elevation above sea level—might make a plausible claim to being the world's tallest. It all depends on what you're measuring and where you begin.

Mauna Kea
19,803 ft
6,037 m

32,100 ft from
summit to
seafloor

Sea level

Ocean depth

-5,000 ft

-10,000 ft

-15,000 ft

Buildings
at the
same scale

Burj Khalifa, world's tallest skyscraper
Empire State Building

Mauna Kea 1

Tallest partially submerged

The Hawaii volcano's summit rises 13,803 feet above the ocean, but the mountain arguably extends far beneath the waves, with 32,110 feet of vertical rise off the seafloor—more than Everest's height above sea level—although it's very gradual.

RANK: 1st 14th



AREA SHOWN ABOVE

Northeast
Pacific
Basin

Northeast Pacific Basin
18,300 ft below sea level



Mt. McKinley (Denali)

Highest off a flat base

Admirers of North America's highest peak above sea level have argued for it as a highest base-to-peak contender on the strength of its seemingly well-defined base. The mountain rises roughly 17,200 feet from low, level tundra.

1st 2nd 18th

Nanga Parbat

Most omnidirectional relief and steepness

Many consider this mountain, in Pakistan, the hardest to climb among the world's 14 peaks that crest 8,000 meters above sea level. Nicknamed "Killer Mountain," it tops the list for ORS because it rises so high and so steeply on every side.

1st 2nd 6th 13th

Annapurna

Most jut

The Nepalese massif's unclimbed southwest face rises from the Kaligandaki River Valley to a peak known as Annapurna Fang or Varaha Shikhar. Its vertical rise and breathtaking steepness make it, by the measure of jut, the world's most impressive mountain face.

1st 5th 10th

Mt. McKinley (Denali)

20,310 ft
6,190 m

Nanga Parbat
26,657 ft
8,125 m

Annapurna
26,545 ft
8,091 m

17,200-ft rise
above the flat
tundra

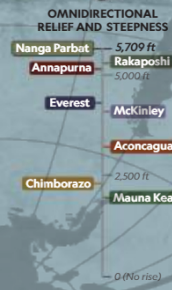
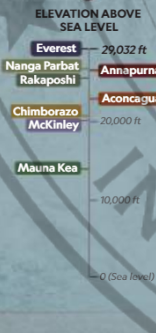
Alaska tundra
(Base of Mt. McKinley)

Tundra

Kaligandaki River Valley

COMPARING THE CRESTS

Only one mountain can come out on top by each method of measure, but many of these behemoth peaks rank highly in more than one category.



OTHER CLAIMS

Rakaposhi, Mauna Kea, and Mount McKinley are all winners by subjective measures only. Each can claim to be tallest from base to peak, depending on how a mountain's base is defined.

BECAUSE EVEREST IS THE HIGHEST POINT ABOVE MEAN SEA LEVEL, IT HAS NO HIGHER POINT TO DEFINE ITS PROMINENCE. TECHNICALLY ITS PROMINENCE CAN BE CONSIDERED ITS ENTIRE 29,032-FOOT ELEVATION.

Charts not to scale with one another

SOREN WALLJASPER, NGM STAFF; ART: TOMÁS MÜLLER; SOURCES: DAVID MEITZLER, KAI XIA, PLANET LABS PBC, NASA SRTM, MAXAR TECHNOLOGIES, 2025; GOOGLE EARTH, NOAA

FIVE WAYS TO MEASURE A MOUNTAIN

Elevation above sea level

Mean sea level is one baseline, but if you're gazing at a summit from any place other than the coast, it likely means that much of a peak's height is measured beneath your feet and not above you.

 **Advantages:** Mountains atop plateaus

 **Disadvantages:** Coastal ranges

Distance from the center of Earth

Our planet isn't a perfect sphere: Centrifugal force from its rotation causes a bulge at the Equator. A mountain rising from this bulge sits up to 13 miles farther from Earth's center than a peak near the poles with a similar elevation above sea level.

 **Equatorial peaks**

 **Summits nearer the poles**

Topographic prominence

Popular with mountaineers, prominence measures a mountain's relative height above its surroundings. How much elevation must you lose while descending a peak before you can begin climbing a taller one? That's prominence, with the low point between them known as the key saddle.

 **Isolated mountains; high points on massifs**

 **Peaks not far from higher ones**

Omnidirectional relief and steepness (ORS)

Most easily understood as measuring the impressiveness of the view from the top of a mountain, ORS relies on a complex formula that averages slope angles and height values between a summit and all points in all directions surrounding it. The formula gives more weight to topography nearer to the peak.

 **Mountains with high, steep faces on all sides**

 **More gradually rising terrain; mountains with inconsistent relief**

Jut

A measure of how dramatically a mountain's most impressive face rises up. For every point surrounding a summit, a mathematical equation assigns a score based on both the vertical rise and the steepness of the angle between them. The one spot where that "angle-reduced height" is greatest becomes the base; the high score itself is the jut.

 **Mountains with at least one high, steep face**

 **More gradually rising terrain**

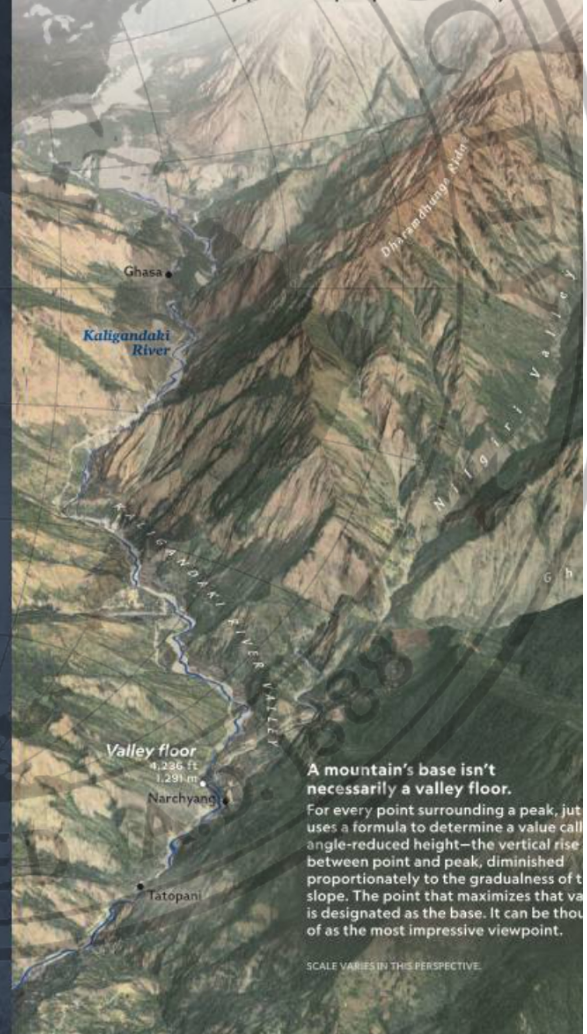


WHY

ANNAPURNA

RISES ABOVE

The high point of the multi-peaked Annapurna range in the Himalaya of Nepal, is the summit known as Annapurna I. It is the world's 10th tallest above sea level. But the second highest peak in the range, known as Annapurna Fang has the planet's highest number that factors in both height and steepness. How impressively a mountain rises above its surroundings. A few key points help explain the newly invented



A mountain's base isn't necessarily a valley floor.

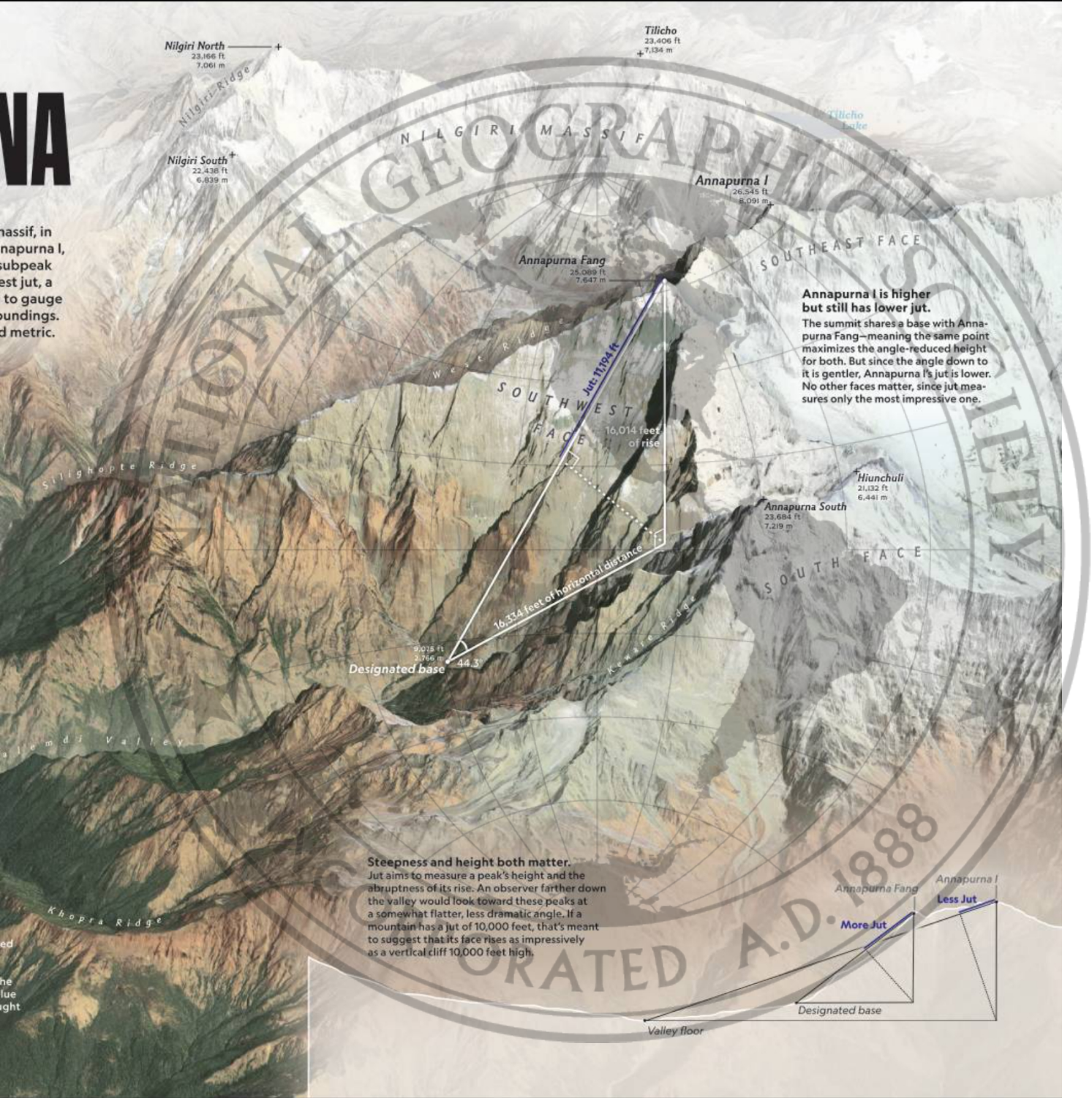
For every point surrounding a peak, jut uses a formula to determine a value called angle-reduced height—the vertical rise between point and peak, diminished proportionately to the gradualness of the slope. The point that maximizes that value is designated as the base. It can be thought of as the most impressive viewpoint.

SCALE VARIES IN THIS PERSPECTIVE.

NA

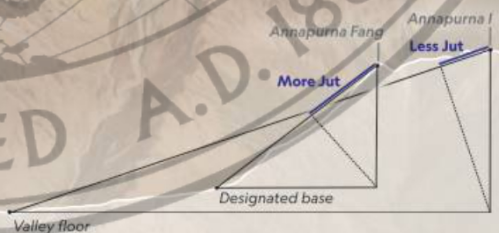
massif, in
Annapurna I,
subpeak
est jut, a
to gauge
oundings.
d metric.

ed
he
lue
right



Annapurna I is higher but still has lower jut.
The summit shares a base with Annapurna Fang—meaning the same point maximizes the angle-reduced height for both. But since the angle down to it is gentler, Annapurna I's jut is lower. No other faces matter, since jut measures only the most impressive one.

Steepness and height both matter.
Jut aims to measure a peak's height and the abruptness of its rise. An observer farther down the valley would look toward these peaks at a somewhat flatter, less dramatic angle. If a mountain has a jut of 10,000 feet, that's meant to suggest that its face rises as impressively as a vertical cliff 10,000 feet high.



ICE HOCKEY
is
FLOURISHING
in...
NAIROBI

There's only one rink in the country—
and it's tiny—but the Kenya Ice Lions
have their sights set on the Olympics.

Words by NEHA WADEKAR

Photographs by KHADIJA M. FARAH

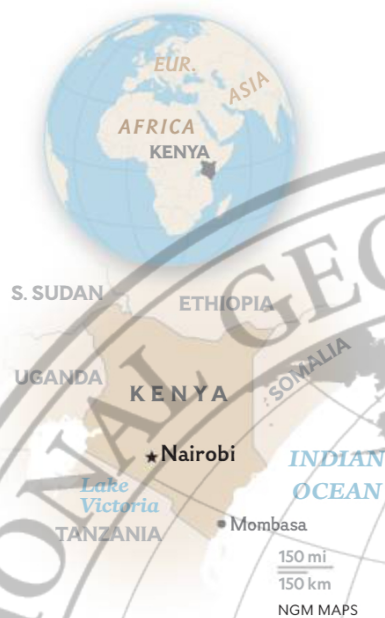
→ **NAIROBI'S PANARI HOTEL** sits alongside a highway between the city center and Jomo Kenyatta International Airport. On the second floor, across from a Chinese restaurant and next to a movie theater, is a small skating rink that serves as the home base for the Kenya Ice Lions, the only ice hockey team in equatorial Africa.

On a recent Wednesday, the arena echoed with the thud of hockey sticks and bodies colliding with the boards. From the bench, players shouted at their teammates in Swahili as they faced off in a five-a-side scrimmage on a rink just a quarter of the size of a regulation National Hockey League rink.

Playing ice hockey in Kenya might have seemed far-fetched a decade ago, but in recent years the sport has drawn participants from all walks of life.

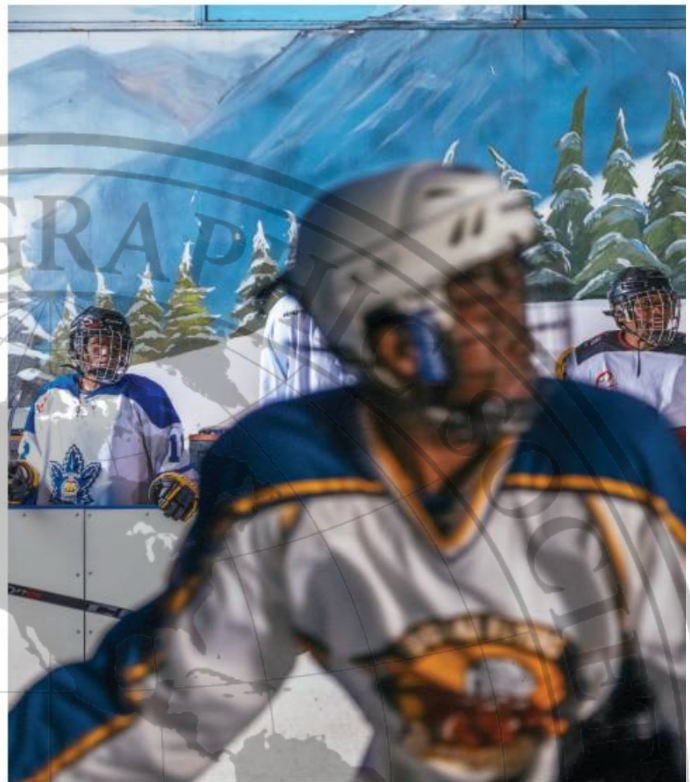






A vast divide exists in Kenya between the rich and poor, but here in Nairobi ice hockey is helping to bridge the gap. The team is made up of “people from very humble backgrounds, and people from the worldlier side of life,” says 30-year-old Ice Lions captain, Benjamin Mburu, who works as an architect and construction manager. Many of the team members are still students; some are unemployed. The sport has also been a lifeline for players like 21-year-old Chumbana Likiza Muhusini, who grew up in one of the city’s harshest slums. None of that matters on the ice. “No one cares about who came from where,” Mburu says.

Last year Kenya became the fifth African nation and just the second sub-Saharan



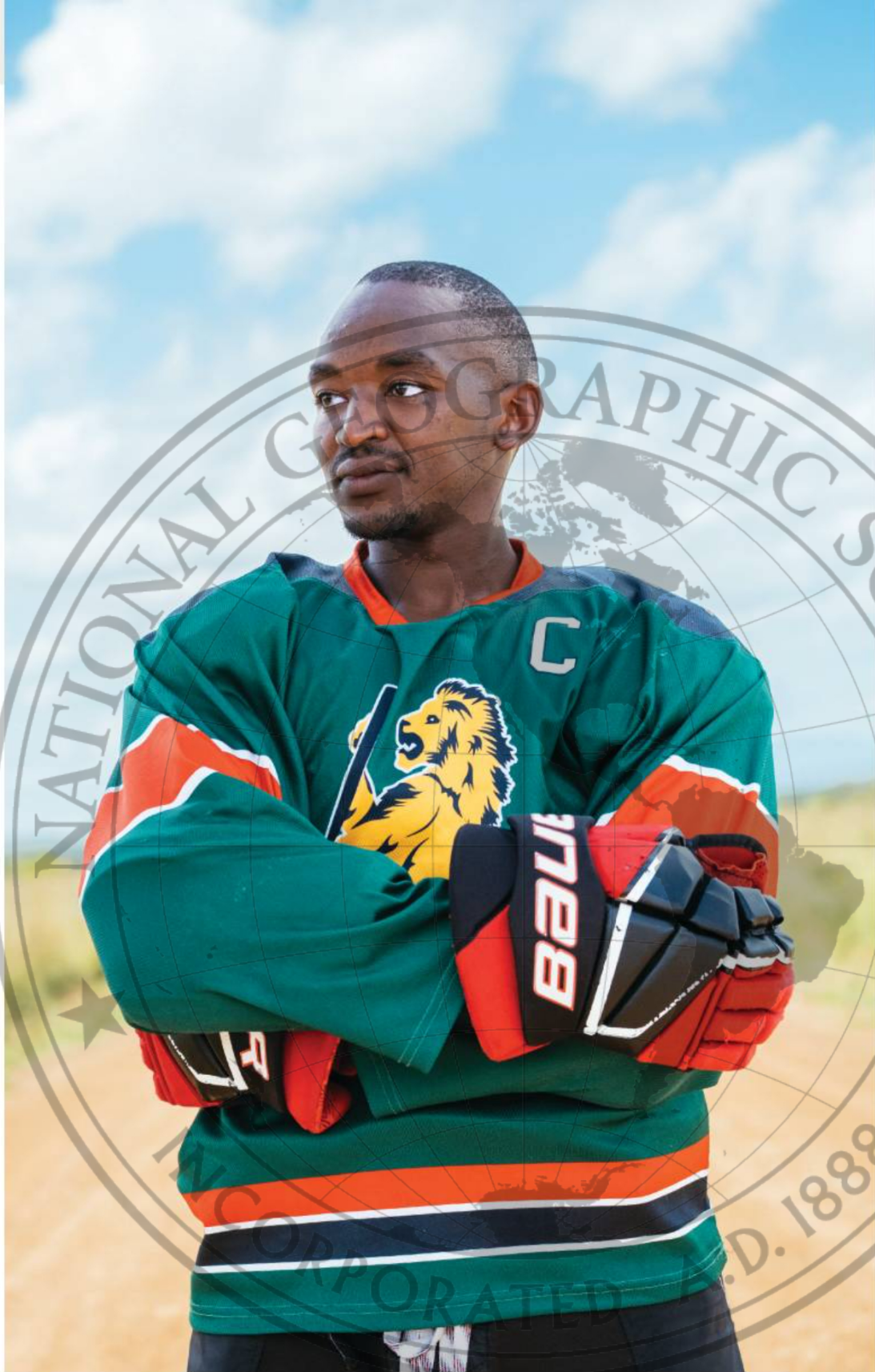
Clockwise from top left

Just out of high school, Hamisi Mwachofu is one of the Ice Lions’ youngest members; much of the gear comes from donations; coach Tim Colby spent a decade leading minor leaguers in his native Canada; the team has won various club tournaments and friendlies against a local group of expats.





Carol Kagendo is a trailblazer of women's hockey in Kenya. She's played for the Ice Lions for five years and recently began coaching in their youth program.



In the past year, team captain Benjamin Mburu has led the squad to three wins at international tournaments.

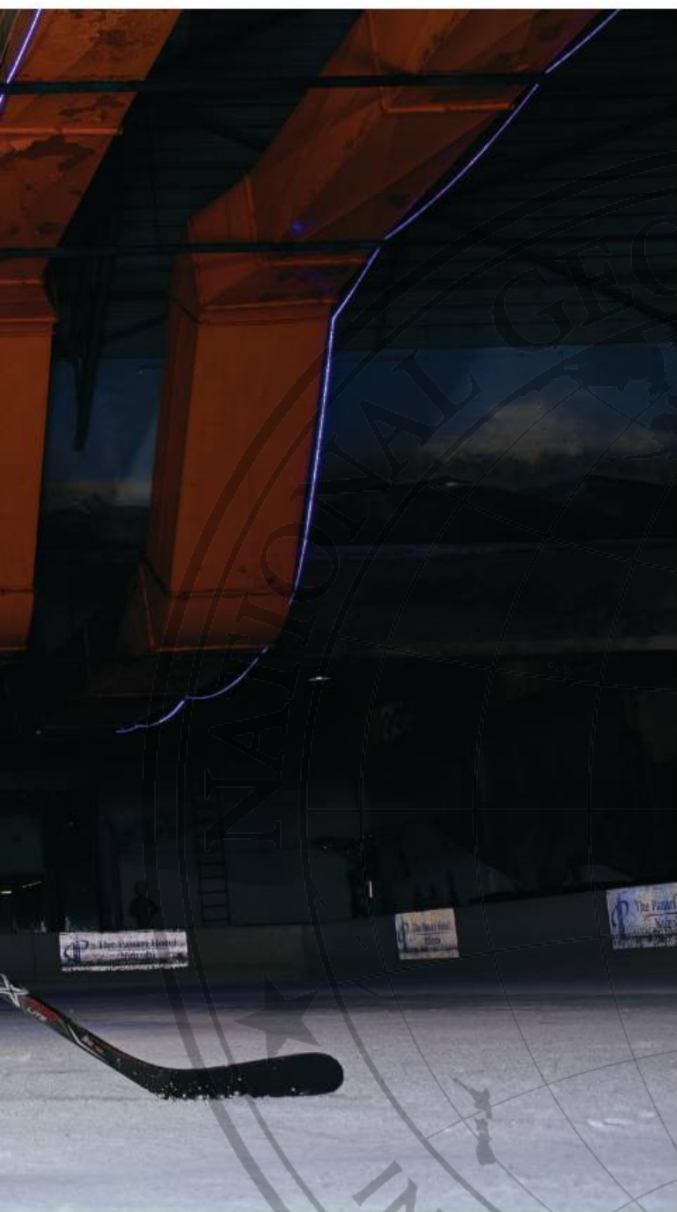


nation to join the International Ice Hockey Federation (IIHF), the global professional body for the sport. It took nearly a decade for the Ice Lions to achieve that recognition.

The team began informally in 2016, when a few young Kenyans working at the rink as skating instructors grew tired of just watching Western expats play hockey and decided to give it a go themselves. Soon they were recruiting players from Nairobi's

rollerblading community, sourcing jerseys and other apparel from the city's second-hand markets, and donning a patchwork of donated gear. "It was super cold, and I couldn't control my skates," Mburu says. "As an African, the closest I ever came to ice hockey was mostly Christmas movies on TV."

It wasn't long before the feel-good story of hockey on the Equator started to spread.



As with many of the Ice Lions, Mike Otieno's hockey career began on in-line skates as a kid. Now he works as a skating instructor at the Panari ice rink when he's not training.

In 2018, an executive at the Chinese multinational company Alibaba learned about the team through Facebook and flew some of the players to South Africa to film a television ad featuring the tagline "Ice hockey in Kenya? No dream is too big."

The TV spot raised the team's profile, but the Ice Lions still had no one to play against—until, later that same year, Canadian restaurant chain Tim Hortons flew the squad to Canada for training and filmed a documentary in which the players received full sets of gear and Kenyan jerseys, met hockey legends Sidney Crosby and Nathan MacKinnon, and competed against a Canadian team. For some of the Kenyans, it was their first time leaving Africa.

The players came home determined to build up Kenya's hockey ecosystem. Today, retired Canadian pro Saroya Tinker is helping the Ice Lions launch a women's league. And the team has begun a Saturday youth clinic to develop a pipeline of talent for future generations. Currently, as many as 70 kids show up for weekend practices.

The squad is coached by Canadian Tim Colby, who spent 10 years at the helm of minor league hockey teams in Ottawa before he moved to Kenya. Unsurprisingly, Colby says the group's greatest hurdle comes down to the cost of ice time in Nairobi: At \$100 an hour, it's too expensive. And the rink is too small. On top of that, the Ice Lions—both players and staff—are all volunteers, and it's tough to run a full-time, professional sports team on a volunteer basis, Colby says.

Despite these challenges, the Ice Lions hope to take part in the first ever African Nations Cup, tentatively scheduled for next June in Cape Town, South Africa. And they plan to work their way up through the many-tiered IIHF World Championship divisions, with the goal of eventually qualifying for the Olympics. "Nothing is impossible," says Mburu. □

WHAT WE GET
WRONG
About the World's
**MOST
MALIGNED
MAP**

The Mercator projection wildly distorts the globe. But that's what makes it useful. Maps based on it are used daily by millions of people.

Map illustration by
MATTHEW W. CHWASTYK

Gerardus
Mercator
1512–1594



→ **CLOSE YOUR EYES** and picture a map of the world. You've likely brought to mind a distorted vision of the Earth based on the work of 16th-century geographer Gerardus Mercator. The Flemish cartographer devised a projection, the technique for representing the three-dimensional Earth in two dimensions, that underpins the most ubiquitous map of the modern era. Nearly 500 years after its creation, the chart still adorns classroom walls, and a digital version, called Web Mercator, is used in almost all the navigation applications in our smartphones.

But the Mercator projection also has its critics, who bemoan the way it distorts reality—Greenland is not that big! Russia isn't larger than Africa! Here's the thing: The geographer wasn't trying to create the perfect map, just a useful one for sailors.

Until Mercator, many world maps had

lines of longitude that curved like parentheses. These maps featured relatively precise depictions of landmasses as geographers knew them, but made navigation a nightmare. Because the maps showed a flat representation of the Earth and didn't accurately account for direction, mariners had to constantly check their bearing.

To remedy this, Mercator portrayed the globe as a flattened cylinder, drawing lines of latitude and longitude that intersected at 90-degree angles. The result, according to Mark Monmonier, a professor emeritus of geography at Syracuse University, was as simple as it was revolutionary. "You could find where you were, where you wanted to go, and draw a straight line connecting those two points." These "rhumb lines" acted as a kind of set-it-and-forget-it course for sailors.

Mercator was well aware that the right

PHOTO: HULTON ARCHIVE/GETTY IMAGES. MAP SOURCES: GREEN MARBLE; UNIVERSITY OF BASEL; USGS

angles that made his map useful for navigating also made it somewhat inaccurate, distorting the relative size of the landmasses. In the past few decades, critics of the Mercator projection have asserted that these distortions fueled colonial and ethnocentric attitudes. Geographers have long proposed alternative projections that address its flaws. For example, National Geographic often uses the Eckert IV projection, which distorts the shape of landmasses, as well as the angles between latitude and longitude, but accurately represents the relative area of the continents.

“All maps have things they do well and other things they might not do as well,” says Monmonier. “You can’t have a map that does everything well—unless you have a globe.” And a globe doesn’t fit in your pocket the way your smartphone does.

The Web Mercator map on your phone takes the best qualities of its predecessor, but the software charts a course for you. While our operating systems and modes of transportation have received significant upgrades since Mercator’s time, our maps remain purposefully antiquated.

—ASHLEY STIMPSON

Right

Modern navigation systems, like the ones on your phone, owe a lot to the math underlying Mercator’s 16th-century breakthrough.

Below

All maps warp the world, but some projections were devised to manage these distortions in a useful way. The Mercator projection prioritizes shape and direction, while the Eckert IV preserves the proportion of areas.

Mercator Projection
useful for navigation



Eckert IV Projection
useful for demographic mapping



MERCATOR'S MASTERPIECE

This map revolutionized how sailors charted courses and made long-distance navigation easier. Mercator used a copperplate engraving process and a printing press for the map's 18 panels, which together measure 78 by 51 inches. Only three originals have survived.



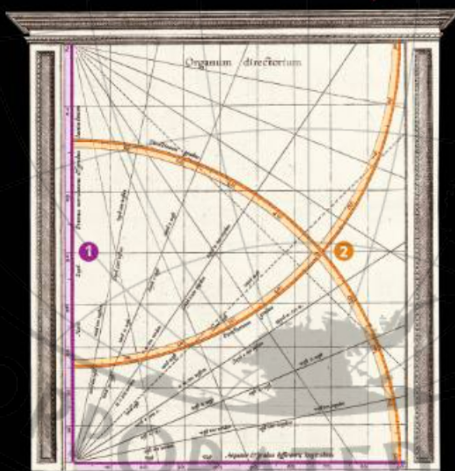
New and Enlarged Description of the World Properly Adapted for Use in Navigation, 1569

SETTING A NEW STANDARD

Before Mercator's game-changing map, navigators typically hugged the coastline or used Portolan charts—graphic representations of written instructions that showed an estimated direction—when crossing the high seas. This new system provided a reliable tool for plotting direction over great distances.

HOW MERCATOR COMBINED ACCURATE COORDINATES WITH PRECISE DIRECTION

- 1 To maintain features' shapes and accurately depict the angles between latitude and longitude, Mercator proportionately stretched the distance between lines of latitude but kept the spacing among lines of longitude the same.
- 2 Straight lines, called rhumb lines, emanate from the center of compass arcs in the left corners. Navigators would use a compass to find their direction, trace the easily measurable rhumb lines, and then maintain a set heading.



How to read a compass rose



Direction is indicated by the points; rhumb lines stretch across water.

Sailing from Lisbon to Pernambuco
Compass headings are correctly shown as straight lines.

AN IDEAL SYSTEM FOR CHARTING A COURSE

To get from plot a straight heading rudimentary of the sun at



Lisbon, Portugal, to Pernambuco, Brazil, mariners would
ht line between waypoints and use a compass to find
they would need to follow. This process, combined with
time measurement, speed tracking, and observation
nd stars, would help them navigate more effectively.

O U R P L A N E T F R O M

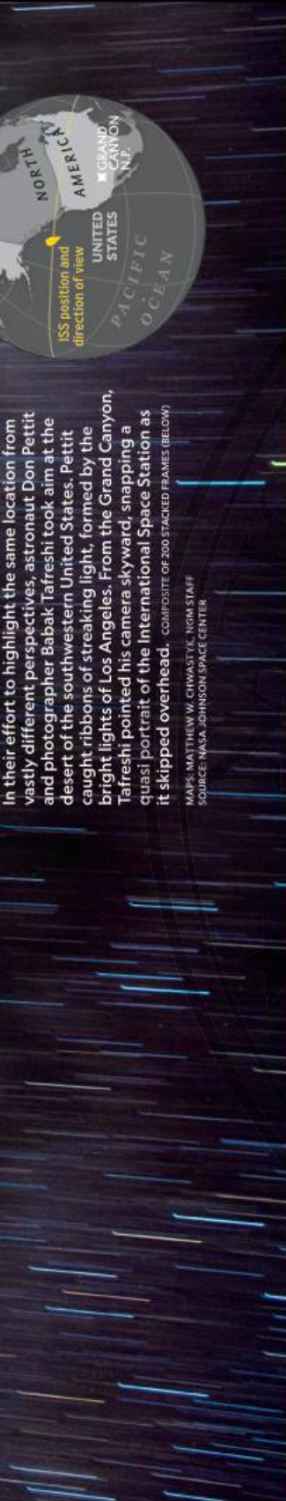
ABOVE & BELOW

WORDS BY MARINA KOREN | PHOTOGRAPHS BY DON PETTIT AND BABAK TAFRESHI

↑ A B O V E

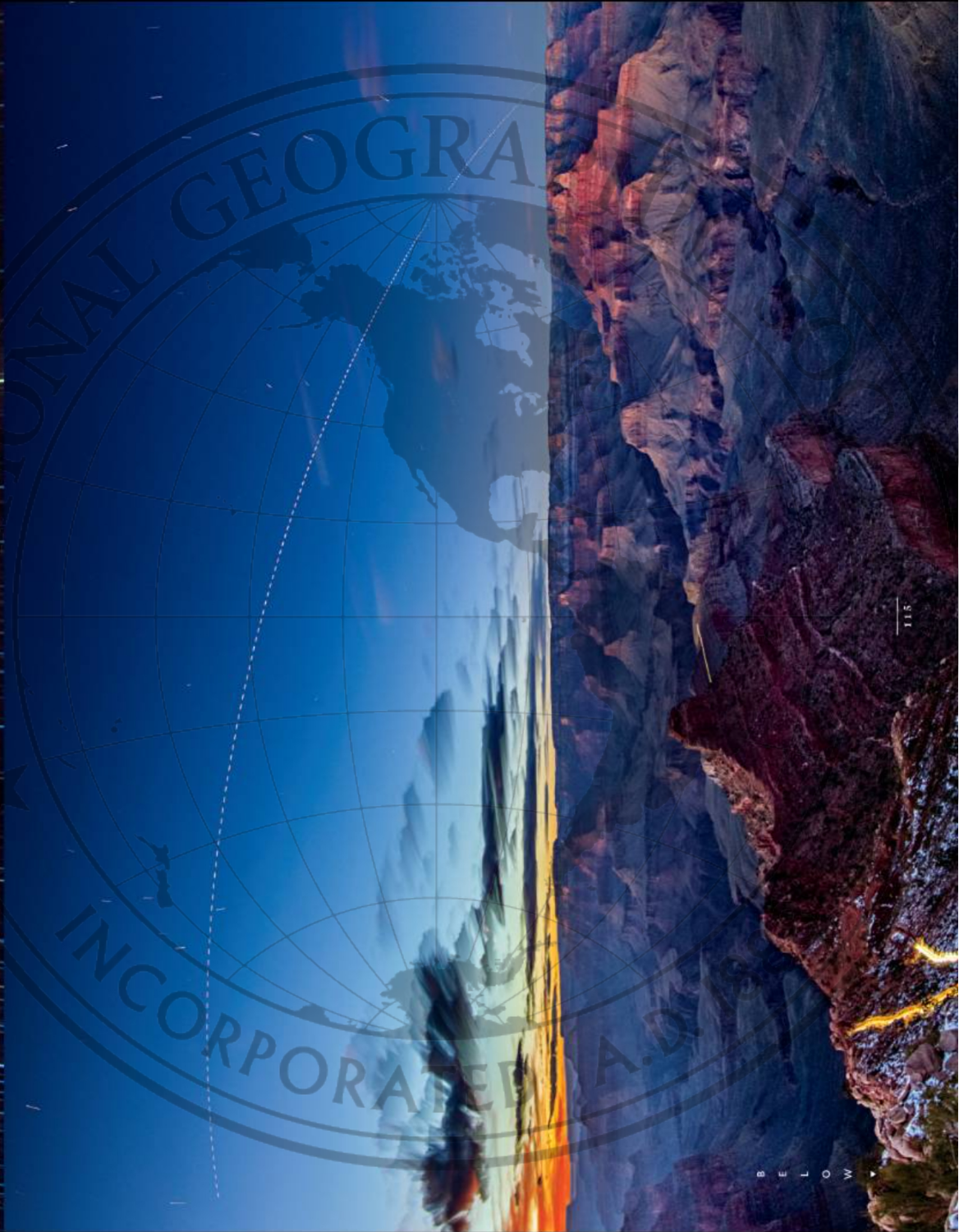
BY CAPTURING THE SAME THING FROM VERY
DIFFERENT PERSPECTIVES, A NASA ASTRONAUT AND
A NATIONAL GEOGRAPHIC PHOTOGRAPHER
CREATE A WHOLE NEW WAY OF SEEING OUR WORLD.

GRAND CANYON



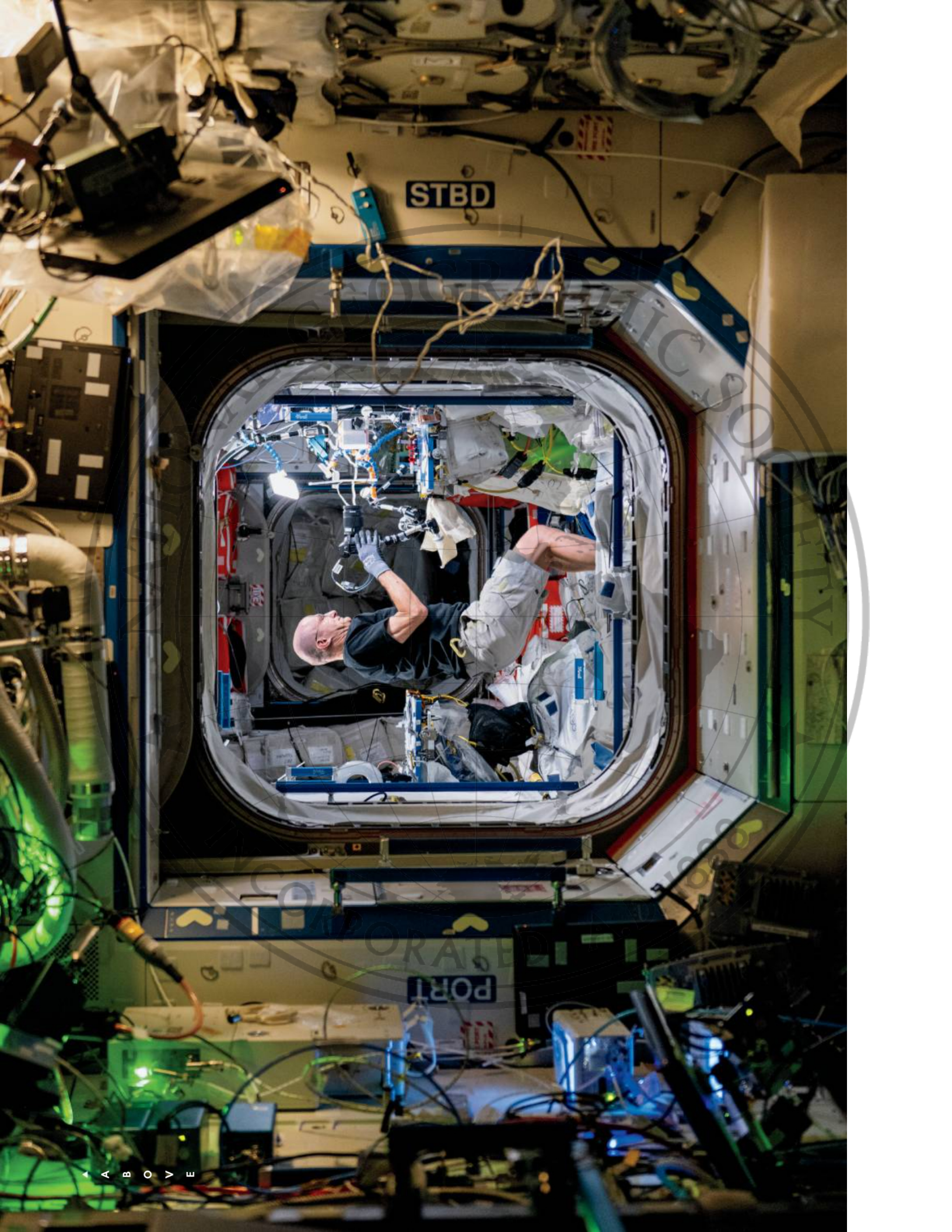
In their effort to highlight the same location from vastly different perspectives, astronaut Don Pettit and photographer Babak Tafreshi took aim at the desert of the southwestern United States. Pettit caught ribbons of streaking light, formed by the bright lights of Los Angeles. From the Grand Canyon, Tafreshi pointed his camera skyward, snapping a quasi portrait of the International Space Station as it skipped overhead. COMPOSITE OF 200 STACKED FRAMES (BELOW)

MAPS: MATTHEW W. CHWASTYK, NOAA/NOAA STAFF
SOURCE: NASA, JOHNSON SPACE CENTER



B E L O W

11.5



Earlier this year, two photographer friends had just finished shooting the Grand Canyon when they began discussing what they might capture together next. Don Pettit was eager to train his camera on Madagascar and sent his friend Babak Tafreshi a text extolling the beauty of the place.

Tafreshi didn't disagree: He imagined the famous baobab trees, with their thick trunks and filigreed branches, cast mesmerizingly against a dark, star-speckled sky. So, even though he was tired from a good bit of traveling, he boarded a flight from Boston to Paris, and then another to Antananarivo, Madagascar's capital city, where he stayed overnight before renting a car and driving out to the remote realm of the baobabs, a dirt road lined with dozens of the ancient trees.

Pettit's journey was simpler: He floated from one room on the International Space Station to another, toward the windows that looked out onto the world.

During his seven-month mission on the ISS, Pettit—who's been an astronaut for nearly 30 years—worked with Tafreshi, a photographer and National



Pettit (top), photographed by one of his colleagues aboard the International Space Station, sets up a science experiment. Outside his official NASA duties, the astronaut found time to document Earth's wonders along with his friend, Tafreshi, captured here in a portrait made by stitching together two panoramic photos taken at the base of a baobab tree in Madagascar.

NASA (ABOVE); AMIRREZA KAMKAR (BELOW)

Geographic Explorer, on an inventive project to photograph the same location or phenomenon from two wildly different perspectives, one photographer standing on the Earth, the other floating 250 miles above it. Together, they coordinated 10 photo shoots across four continents. The result is a celestial scrapbook of our planet, with spellbinding scenes that can make you feel grounded and weightless at the same time.

The pair initially connected not long after Pettit's first stay on the then newly assembled ISS, in 2003. Pettit, an amateur photographer since sixth grade, had brought his digital cameras with him, and he'd used some scavenged station materials to fashion a camera mount that provided the stillness necessary to capture the night sky without smears of starlight. (Pettit, a scientist by training, is among NASA's craftiest astronauts; he once designed a drinking cup to make sipping coffee easier in microgravity.) At the time, Tafreshi was working as an editor at the Iranian astronomy magazine *Nojūm*. He had taken up photography as a teenager, focusing on the night sky and the natural wonders that become visible in the absence of light pollution. When

Pettit's pictures reached Earth, Tafreshi emailed the astronaut with compliments. Soon they became pen pals.

Years later, as their correspondence grew into a photo project, Pettit and Tafreshi found that it helps to have different approaches to telling visual stories about Earth. Pettit, in particular, felt a duty to share his orbital vantage point with his fellow humans on Earth. "You want to share that imagery to people that don't necessarily have the wherewithal to be there in orbit," Pettit said.

Over the course of their project, the duo sought to synchronize their photo shoots, which required a tremendous amount of planning. They needed to account for orbital mechanics; from his perch on the ISS, Pettit circled the globe every 90 minutes, racing sunrises and sunsets. The trajectory of the space station mattered as well. When the pair first started brainstorming potential areas of interest, Tafreshi had plenty of ideas. "I told him, You know, Iceland is great," Tafreshi recalled. But the ISS, Pettit replied, never flies over Iceland. Earthly considerations influenced the project too. Pettit once suggested a couple of regions that appeared photogenic from hundreds of

miles up, but they were along the borders of countries in conflict—India and Pakistan, and North and South Korea—"so I couldn't travel there because of safety matters," Tafreshi said. Pettit, meanwhile, had to work around his astronaut duties. "When you're on station, you've got a pretty encompassing day job," Pettit, who has logged nearly 600 days in space across four missions, told me. "You need to make sure that there's a hole in your work schedule where you can run to the cupola and take a few pictures."

Sometimes the universe went easy on them. A comet, visiting from the edges of the solar system, showed up a week after Pettit reached orbit. Tafreshi observed the bright object in Puerto Rico, but Pettit "had the best view," without Earth's hazy atmosphere, with its pesky clouds, in the way. Not long after that, a major aurora storm appeared in the skies over Tafreshi's house—how convenient!—and the photographers captured the event within hours of each other, their best timing of the entire endeavor. When it comes to the rippling, mystical green lights, two views are better than one. "If you look at the same ripple from orbit, you might find that it's actually an oval," Pettit said. It's

as if they had surrounded the shimmering phenomenon, revealing its true nature.

While Pettit was spared the difficulties that can ruin a photographer's day on the ground—rainy weather, for example—his cameras would occasionally malfunction because of the constant, invisible barrage of cosmic radiation, and now and again artifacts of astronaut life sneaked into his shots. Once, Tafreshi was scanning Pettit's images of the Maldives, in the Indian Ocean, when he noticed an intriguing patch of green in the water—an algal bloom? "I was so excited until I got the next few shots and I realized, This patch is moving very fast," Tafreshi said. It turned out to be a weight-lifting machine, reflected in the space station's windows. "Every crew member works out on this machine for an hour and a half a day," Pettit said. He would occasionally ask his colleagues if they wouldn't mind turning off the lights and working out in the dark, just for a few minutes. Not everyone obliged.

Pettit and Tafreshi both believe that space photography is better done by people; there are plenty of satellites that take images of Earth from orbit, but often these pictures are flat and textureless.

Pettit can play around with light and shadow, creating a richer portrait. And an orbital view of Earth is more meaningful when there is real emotion behind it. Karen Nyberg, a retired NASA astronaut, told me that she liked photographing the places where she knew her loved ones were. "I would go over Houston, or go over when they were visiting upstate New York, and feel very connected to them because I was only 250 miles away, just directly above them," Nyberg said. "And then I would actually start to feel kind of this connection with people in other places on the Earth that I don't know." There's also perhaps a hint of triumph in it; human bodies were not made to be in outer space, but there astronauts go, soaking up the wonder and sharing it with the rest of us.

In more than two decades of friendship, Pettit and Tafreshi have met in person only a handful of times. They communicate mostly via text and email. They told me they don't really talk about their personal lives or get too philosophical, despite the nature of their work; their conversations are the stuff of true shutterbug geekery, all about f-stops and imaging software. Still, they're not just

photography buddies. When Tafreshi was robbed in Sicily and lost most of his equipment, he withheld the depressing details from Pettit because he didn't want to worry him, explaining to me that it's best practice not to upset an astronaut far from home. Pettit gently razed him, saying that Tafreshi should be more careful about where he keeps his passport, which had been stolen too.

The Madagascar shoot was their last session before Pettit returned to Earth. The region has little artificial light, so Pettit's shot hinged on the very alignment of celestial bodies—the presence of a full moon—to illuminate a landscape shrouded in nighttime. Tafreshi stood in the brush, taking in the shimmer of the Milky Way in the unspoiled sky. "It was surreal," he said. The evening quiet was punctuated by the nocturnal murmurings of unseen wildlife and of villagers passing by in carts pulled by mules. From above, Earth is a gleaming world with a wispy atmosphere in an inky void. From below, it is a tangle of flora, fauna, and humanity that, as far as we know, doesn't exist anywhere else. The resulting diptychs present Earth as it truly is—just another planet, and our only home. □

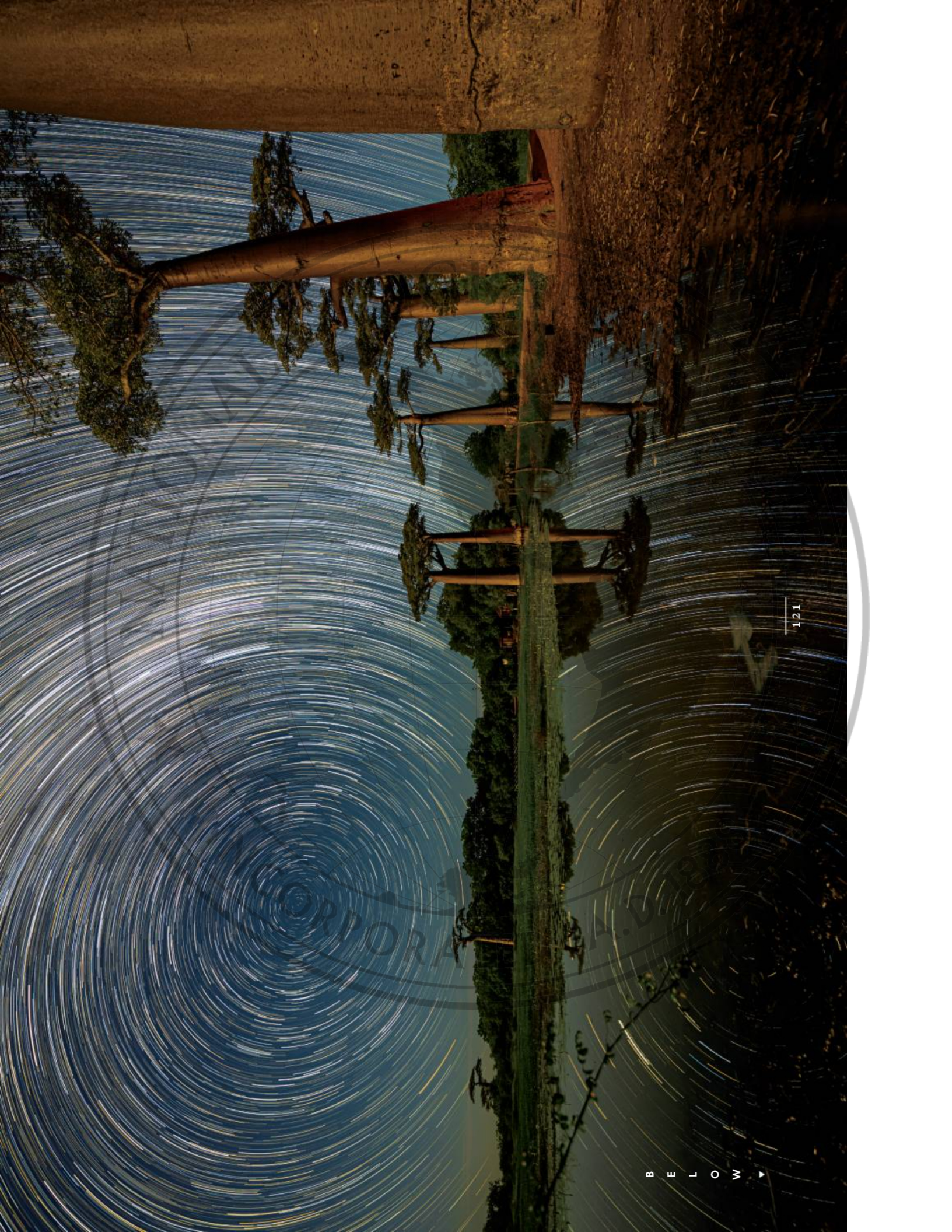


▲ A B O V E

MADAGASCAR

With dense networks of forest and few major cities, Madagascar appears shrouded in a blanket of darkness when viewed from Pettit's perspective aboard the ISS. From the ground, Tafreshi photographed the island's famed baobab trees against a backdrop of swirling star trails that converge around the celestial south pole. COMPOSITE OF 219 STACKED FRAMES (BELOW)









POWERFUL AURORA

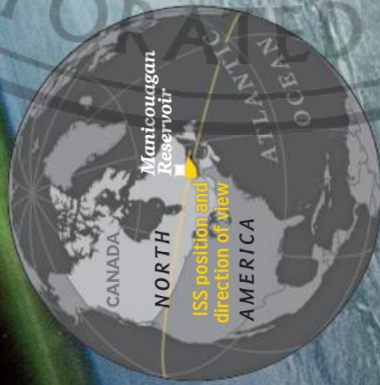
On October 10, 2024, a strong geomagnetic storm lit up the Northern Hemisphere with colorful auroras. Pettit rushed to one of the ISS's windows to document the vibrant curls of green and pink light before they vanished. Fortunately, Tafreshi didn't have to travel far. He captured the same swirling pink phenomenon above his neighborhood in Salem, Massachusetts.

NATIONAL GEOGRAPHIC





▲ A B O V E



MANICOUAGAN CRATER, CANADA

Over 214 million years ago, an asteroid slammed into Canada and created the Eye of Quebec, a 62-mile-wide crater clearly visible from Pettit's vantage point aboard the ISS. In the years since, that crater has filled with water, forming the Manicouagan Reservoir. At dusk one evening along the reservoir bank, Tafreshi turned his camera toward the cosmos, highlighting sinewy streaks of starlight. COMPOSITE OF 400 STACKED TIME-LAPSE FRAMES (BELOW)







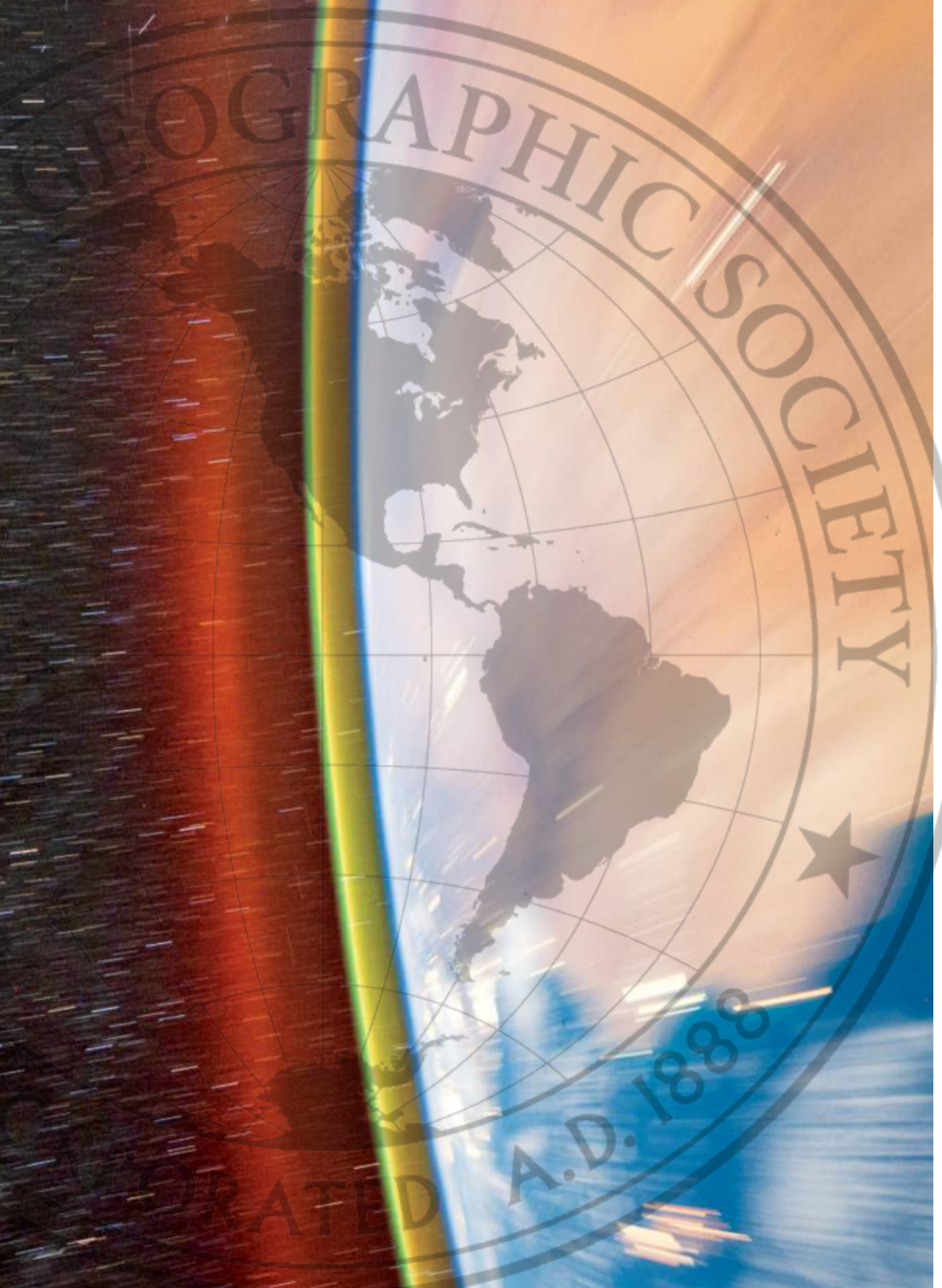
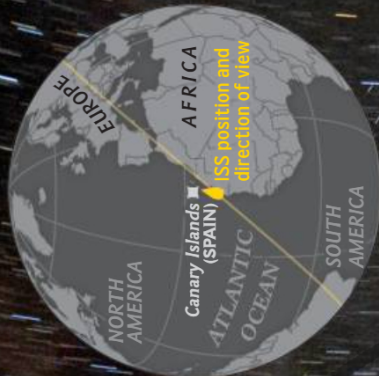
FLORIDA

Atoms and molecules in Earth's upper atmosphere, excited by sunlight, form a faint red haze high above Florida. Pettit spent nearly 600 days in space and often launched from Cape Canaveral. On a dark, star-studded night, Tafreshi observed a similar launch—this time of cargo via SpaceX's Falcon 9 rocket—from Merritt Island National Wildlife Refuge.

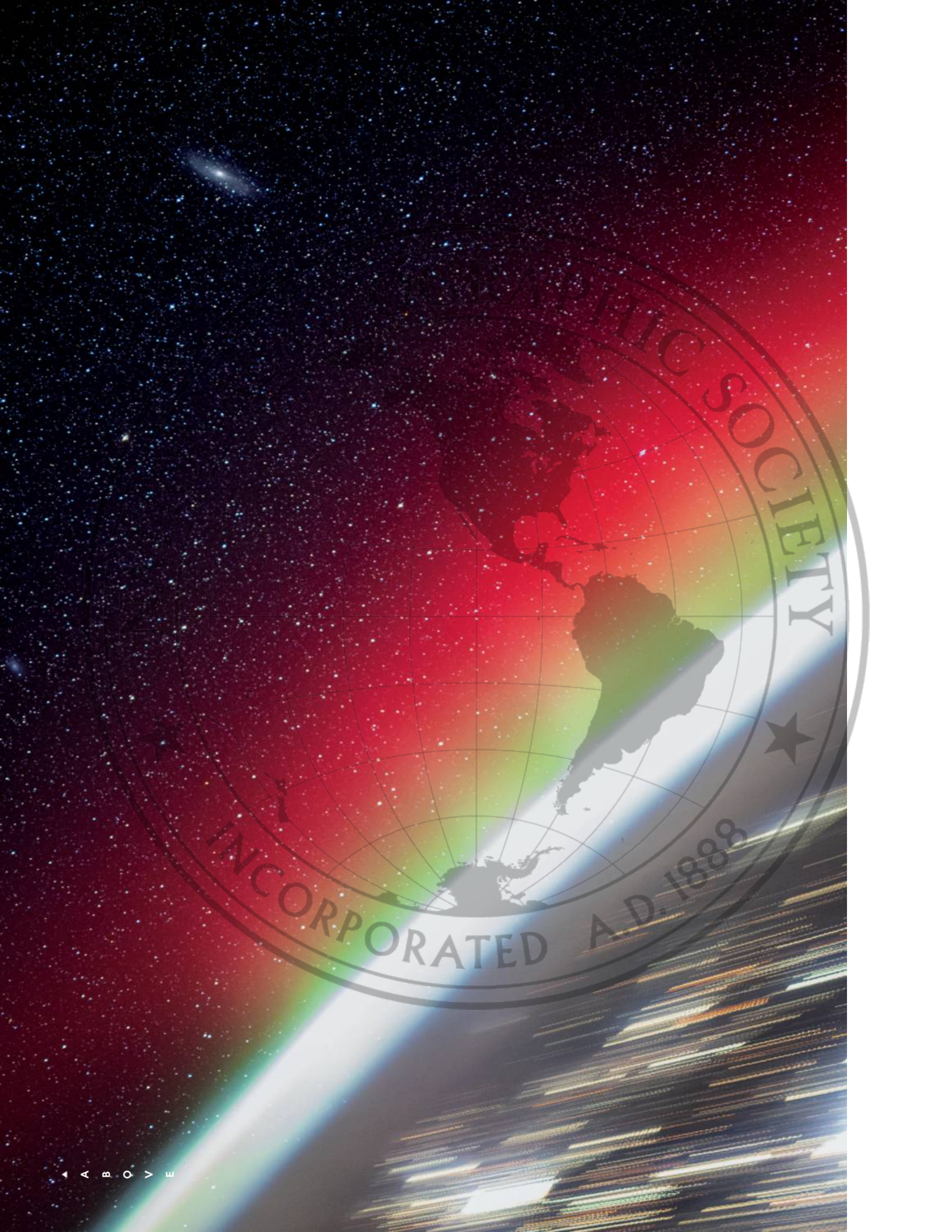
COMPOSITE OF 1100 TIME-LAPSE FRAMES (BELOW)

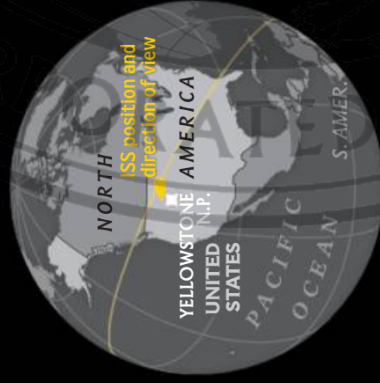
CANARY ISLANDS

Traveling at speeds of around five miles per second, the ISS zipped over the Canary Islands, and Pettit captured the Milky Way just beginning to peek out over Earth's horizon. From a 7900-foot-high summit in Caldera de Taburiente National Park in La Palma, Tafreshi recorded his own view of the rising Milky Way.









YELLOWSTONE

As the ISS sailed above the Montana-Wyoming border, Pettit used a 10-second exposure through his 50-mm lens to photograph Earth and one of its celestial neighbors, the Andromeda galaxy, which lies just 2.5 million light-years away. Yellowstone National Park's Castle Geyser erupts before a backdrop of star trails in this 65-frame composite by Tafreshi.



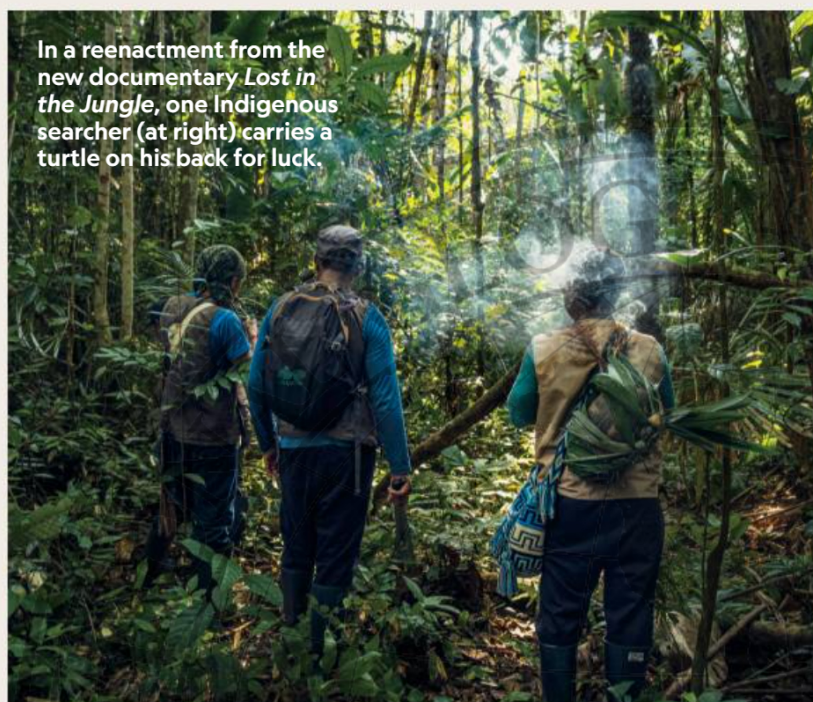


A COMET'S TAIL

Though comet A3's trajectory has brought it no closer than 44 million miles to our planet, it appears to pierce Earth's atmosphere in Pettit's photograph. From Vieques, Puerto Rico, Tafreshi documented the comet, which would become the brightest one to streak across the sky in decades, as it sailed across a blush-pink sunset.



NATIONAL GEOGRAPHIC SOCIETY
INCORPORATED 1888



In a reenactment from the new documentary *Lost in the Jungle*, one Indigenous searcher (at right) carries a turtle on his back for luck.

TELEVISION

→ **THE PLANE**, a Cessna six-seater, went down in a stretch of Colombian rainforest that might have challenged even the most prepared jungle trekkers. The crash killed the pilot and two passengers, including Magdalena Mucutuy, a member of the Huitoto community who was relocating to Bogotá from her home on Indigenous reserve land in the Colombian Amazon. The only survivors: Mucutuy's 11-month-old baby and three older children, ages 13, 9, and 5.

What followed is an incredible

story of resilience and hope, told by National Geographic Explorers Chai Vasarhelyi and Jimmy Chin, along with Juan Camilo Cruz, in the new documentary *Lost in the Jungle*. Just as inspiring as the Mucutuy children's courage is the unprecedented rescue effort coordinated by the Colombian military and searchers from Indigenous communities—groups long at odds, briefly united in common purpose. *Coming to National Geographic and Disney+ starting September 12. Check local listings.*

BOOKS



From Circe to Salem to #witchtok, supernatural beliefs and rituals have shaped every culture and era. *Book of Magic and the Occult: A Visual History* is a spellbindingly comprehensive look at how.

NEWSSTANDS



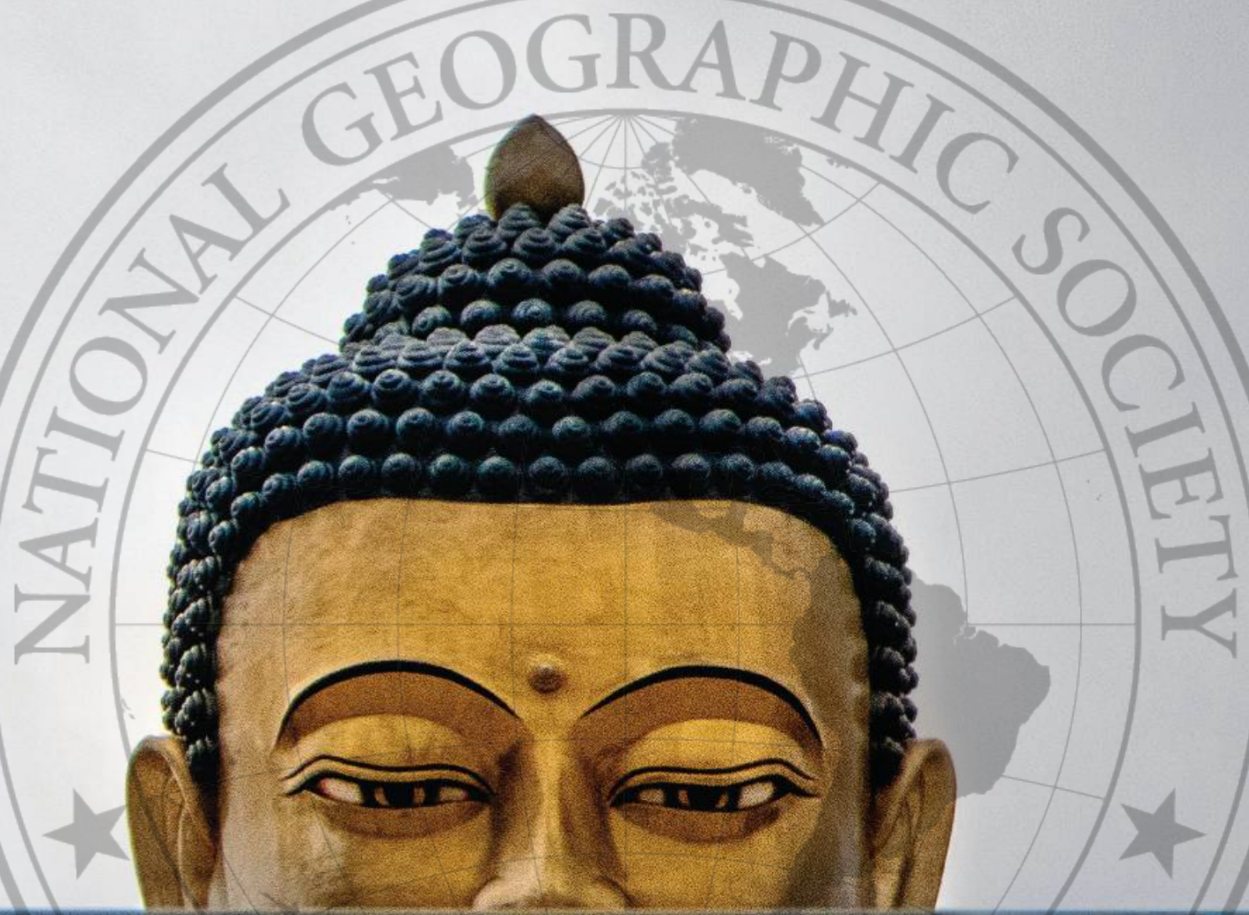
That furball on your lap? Smarter than you think. Our special issue *The Genius of Cats* looks at the surprising science behind feline social intelligence and the clever ways that domestic cats communicate with their humans (or try to, anyway).

Customer Service For subscriptions or changes of address, visit ngmservice.com or call 1-800-647-5463. Outside the U.S. or Canada, call +1-515-237-3674.

Contributions to the National Geographic Society are tax deductible under Section 501(c)(3) of the U.S. tax code. I Copyright © 2025 National Geographic Partners, LLC. All rights reserved. National Geographic and Yellow Border: Registered Trademarks. Marcas Registradas. National Geographic assumes no responsibility for unsolicited materials. Printed in U.S.A. For corrections and clarifications, go to natgeo.com/corrections.

NATIONAL GEOGRAPHIC (ISSN 0027-9358) PUBLISHED MONTHLY BY NATIONAL GEOGRAPHIC PARTNERS, LLC, 1145 17TH ST. NW, WASHINGTON, DC 20036. \$79.00 PER YEAR FOR U.S. DELIVERY; \$89.00 TO CANADA, \$89.00 TO INTERNATIONAL ADDRESSES. SINGLE ISSUE: \$15.00 U.S. DELIVERY, \$30.00 CANADA, \$35.00 INTERNATIONAL. (ALL PRICES IN U.S. FUNDS; INCLUDES SHIPPING AND HANDLING.) PERIODICALS POSTAGE PAID AT WASHINGTON, DC, AND ADDITIONAL MAILING OFFICES. POSTMASTER: SEND ADDRESS CHANGES TO NATIONAL GEOGRAPHIC, PO BOX 37545, BOONE, IA 50037. IN CANADA, AGREEMENT NUMBER 1000010298, RETURN UNDELIVERABLE ADDRESSES TO NATIONAL GEOGRAPHIC, PO BOX 819 STN MAIN, MARKHAM, ONTARIO L3P 9Z9. EDITEUR RESP. POUR LA BELGIQUE: MARCO PROVASI-EMD BELGIUM SA, RUE DE GRAND BIGARD 14 - 1082 BRUXELLES - BERCHER SAINT AGATHE. REPR. EN FRANCE: EMD FRANCE SA, BP 1029, 59011 LILLE CEDEX; TEL. 320.300.302; CPPAP 0725U89037; DIRECTEUR PUBLICATION: D. TASSINARI. DIR. RESP. ITALY: RAPP IMD SRL, VIA G. DA VELATE 11, 20162 MILANO; AUT. TRIB. MI 258 26/5/84 POSTE ITALIANE SPA; SPED. ABB. POST. DL 353/2003 (CONV. L27/02/2004 N.46) ART 1 C. 1 DCB MILANO STAMPA. QUAD, MARTINSBURG, WV 25401. SUBSCRIBERS: IF THE POSTAL SERVICE ALERTS US THAT YOUR MAGAZINE IS UNDELIVERABLE, WE HAVE NO FURTHER OBLIGATION UNLESS WE RECEIVE A CORRECTED ADDRESS WITHIN TWO YEARS.

THERE'S MORE THAN ONE GUIDE ON THIS TRIP



On day one of the Bhutan: Land of Mysticism and Mythology trip, you'll be blessed for safe travels by a monk. So, as you roam through awe-inspiring sights like the captivating Tiger's Nest Monastery or the colossal Great Buddha Dordenma statue, you can take comfort in the fact that there'll always be someone guiding you through it all.



EXPEDITIONS

NATGEOEXPEDITIONS.COM | 1-888-249-7237

© 2025 National Geographic. Fla. Seller of Travel Reg. No. ST44028 CST 2074630



ALLERGEN SENSITIVITIES WON'T KEEP US APART

PROVEN
NATURAL NUTRITION

DAY **1**

REDUCES MAJOR ALLERGEN IN
CAT HAIR BY 47% STARTING ON

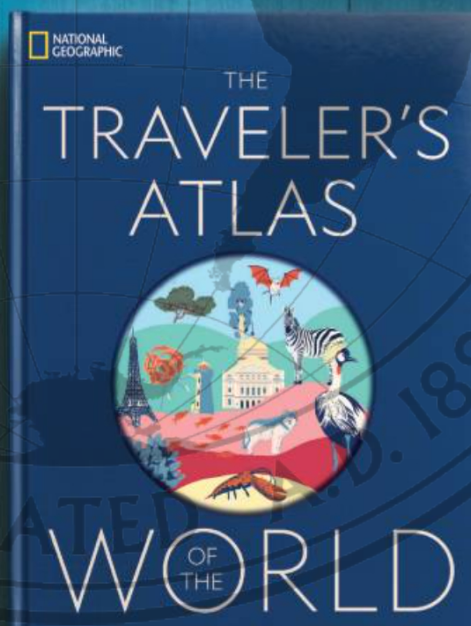
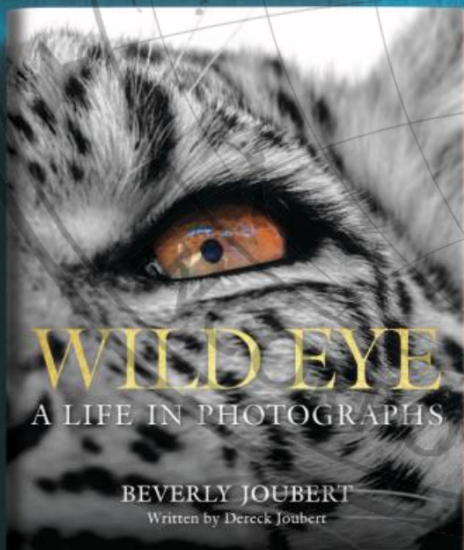
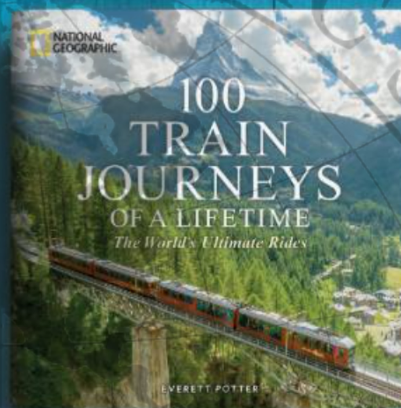
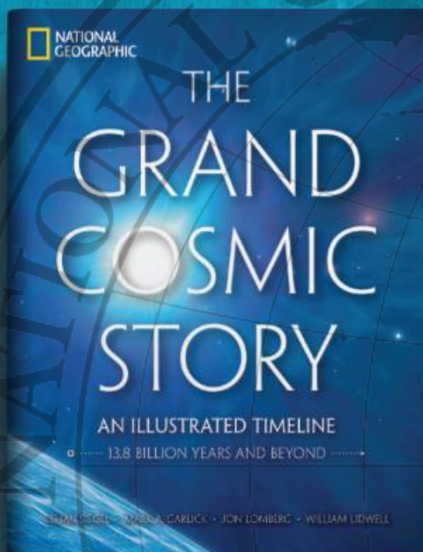
DAY **21**

A
Difference
From Day



Your Pet, Our Passion.®

EXPLORE THE WORLD BEYOND:
BOOKS FOR THE **ADVENTUROUS SOUL**



AVAILABLE WHEREVER BOOKS ARE SOLD

  NatGeoBooks

© 2025 National Geographic Partners, LLC

 NATIONAL
GEOGRAPHIC